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The Society is not responsible, as a body, for the facts and opinions advanced in the papers published by it. Editorials are by the Editor-in-Chief unless otherwise indicated and do not necessarily represent the opinion of the Society as a whole.

EDITORIAL

A CHAPTER IS ENDED: ANOTHER BEGINS

THE past four years have been memorable years for the Society of American Foresters. Never before has the Society been so virile, so active, so forceful. Never before has it fought so militantly for sound professional principles. Never before has it assumed so many responsibilities. Never before has its membership been so large. Never before has it attempted so adequately to serve its members. In short, the shield of the Society has become the symbol of professional service and integrity.

It is a mistake to assume that this progress has been largely fortuitous. Real progress is never largely fortuitous. It is made only by men who, placing service above self, take advantage of existing circumstances; it is made only by the expenditure of great effort, by giving painstaking attention to details, and by the assumption of responsibilities, however unpleasant; and by timely, wise, and prudent action.

The officers and some members of Council who have guided the destinies of the Society for the past four years have now retired from office. To them the Society is deeply indebted. They have elevated the tone of Society activities. They have established a standard of service future officers of the Society must strive to maintain. They have served the Society well. Their services will long be remembered by a grateful Society. A most interesting chapter in the history of the Society is ended.

Great advances always result in great stresses. This is just as true for professional advances as it is for social and political advances. Alignments change. Personal relationships change. Yes, unfortunately, even friendships change. The Society has experienced a period of ever increasing stresses. These must be relieved.

Years ago foresters developed an *esprit de corps* which was the envy of other professional groups. Many factors contributed to this development. From the very beginning forestry attracted an unusually fine group of young men, men of vision, men of courage, men in whom the spirit of adventure and of public service ran high. All had a common objective. All fought a common enemy. All had inspiring leadership. Far flung though the group was, mutual understanding and mutual respect developed rapidly. There were few cliques. The major issues were few in number and on these there was quite general agreement. Differences of opinion there were, but these seldom involved fundamental social, political, or

economic questions. In the field as elsewhere little if any distinction was made merely because of rank or position. Men in the higher positions knew the men in the lower positions. These were not casual official acquaintanceships. They were personal living friendships forged in the heat of battle and tempered in the soft glow of the evening campfire. As the number of foresters increased, as forestry expanded and grew to maturity, and as procedures and operations became standardized, the opportunities for making strong lasting friendships became less favorable. But much mutual understanding and many strong friendships still remain in the profession.

The inauguration and development of the emergency conservation program gave impetus and momentum to a transition already well under way. The number of men in professional forestry increased rapidly. Many had few opportunities to associate with other foresters. Because the rate of influx was so rapid and also because of the isolation of many of these new foresters their amalgamation in a wholly unified professional group was improbable, if not almost impossible.

Difficult though this problem may be of solution, it is not the most difficult one confronting the Society. Far from it. Probably one of the most significant changes that has occurred in America during the past few years has been the development of a definite social and class consciousness. Social and economic affiliations and beliefs are no longer taken lightly. No longer are they merely academic questions. They have become and probably will continue to be living vital issues. As such, they profoundly affect professional attitudes and, consequently, professional societies. Evidence of this may be seen in the American Medical Association, in which socialized medicine has become a highly controversial issue. Because of the many social implications in forestry, it is not unlikely that the clash of social and economic ideas ultimately will affect the administration of the Society.

These problems are not raised for condemnation or approbation. They are raised only in explanation of certain centrifugal and disruptive forces in the Society. Such forces, disconcerting though they at times may be, are not without benefit. Without them organizations become set, inelastic, and unresponsive. With them organizations tend to change somewhat more rapidly, to more nearly keep in tune with changing social and economic conditions, to more nearly keep in step with changing political philosophies.

New officers who will guide the Society's destinies for a two years' period have been elected. They have been elected by democratic vote of the members of the Society. Their election has not been by unanimous vote—democratic elections never are. They have run on no platform. They have received no mandate, direct or implied, from the members of the Society. There has been little or no campaigning for "favorite sons", no pressure groups, no coercion. The newly elected officers are the free choice of the Society majority. They have been elected on the basis of their professional qualifications alone. They are entitled to and must receive the wholehearted support of the entire membership of the Society.

Another chapter now begins. The new officers will be faced with many difficult problems. To them the Society has given freedom of action. To them the Society now will look for guidance and leadership. To them it will look to hold the advances that have been made. To them will the Society look to rebuild the old *esprit de corps* of professional foresters with all its old glamour, worth, and value. Golden days lie ahead! We must but make them so!

STANDARD TERMS FOR DESCRIBING WOOD

By L. J. MARKWARDT and G. E. HECK

Forest Products Laboratory[1]

The longfelt need for precise terms to describe the various physical and mechanical properties of wood is met in the following article. A graduated set of descriptive terms, each corresponding to a certain numerical range of the property under consideration, is used to permit an accurate evaluation of the property and to afford a uniform basis of comparison between species. Foresters may well keep the article at their finger tips when preparing material for publication.

IN discussing the properties and characteristics of different species of wood we often find it desirable to describe them broadly by means of descriptive terms, rather than by quoting precise numerical strength values. The practice of using general descriptive terms is for this reason well established in forest tree literature. Not well established, however, is any uniformity in the use of descriptive terms, nor are the terms used nearly as closely correlated with the actual mechanical properties as is possible from existing knowledge. Thus, one book on trees describes American elm as "heavy, hard, strong, ..." and describes red oak with the same words, thereby giving an impression of far closer equality of properties than is known to exist, and failing to bring out the exceptional characteristics of each.

In order to obviate the confusion that often arises from indiscriminate use of descriptive terms, or the lack of properly correlated terms, the Forest Products Laboratory has developed a series of standard terms for describing wood. Ten terms have been set up for each property, thus giving a relatively wide range of expression. At the same time the adoption of ten terms permits the use of a corresponding decimal scale of numbers for each property in lieu of the descriptive terms, if so desired. Compare the greater precision of the standard terms in differentiating between American elm and red oak in the following example, as against the description previously quoted:

American elm has a large shrinkage (7), is moderately heavy (6), moderately weak in bending and compression (5), moderately stiff (6), moderately hard (6), and high in shock resistance (7).

White oak has a large shrinkage (7), is very heavy (8), moderately strong in bending and compression (6), stiff (7), hard (7), and high in shock resistance (7).

The numbers in parenthesis indicate the respective properties in the decimal scale referred to. From the descriptions presented with this more precise yardstick, it is very evident that American elm, for its weight, has a relatively large shrinkage, and is unusually shock resistant; these are two of its particularly characteristic properties.

The various descriptive terms for six important properties are listed in Table 1. Each descriptive term for each property embraces a given numerical classification range, having definite numerical limits. The figures making up the classification limits are known as "comparative strength values" and are derived from specific numerical test data by means of

[1]Maintained by the U. S. Forest Service at Madison, Wis., in cooperation with the University of Wisconsin.

reduction and weighting factors as explained in U. S. Dept. Agr. Technical Bulletin 158.[2]

Table 2 presents comparative strength values on 164 species of woods grown in the United States, together with the corresponding descriptive terms. The descriptive terms are abbreviated in Table 2, but the complete term can be readily ascertained from reference to Table 1. For example, in Table 2, the comparative figure for hardness of red alder is 48. Reference to Table 1 shows that the descriptive term corresponding to this hardness value is given as "moderately soft" which in turn agrees with the abbreviation "MS" presented in Table 2 as the hardness descriptive term for red alder.

When the results of standard test data on small clear specimens of any species are available, the required comparative strength values can of course be readily computed by the detailed procedure presented in U. S. Dept. Agr. Technical Bulletin 158. Conversely, when standard strength data are not available for a species, it is impossible to assign descriptive terms under the system presented here. In other words, if only the specific gravity of a species is known, that species can only be accurately classified as to specific gravity or weight, and not as to its other properties.

This system of standard descriptive terms was first developed by the Laboratory more than 20 years ago, but more recently has been revised and expanded. This method was used in describing species referred to in U. S. Dept. Agr. Technical Bulletin 226, "The Distribution and Mechanical Properties of Alaska Woods." It is believed that the general use of standard terms will result in more precise evaluation of the various important physical properties of wood, as well as to eliminate the confusion resulting from the use of indiscriminate or uncorrelated terms.

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[2]Comparative strength properties of woods grown in the United States, U. S. Dept. Agr. Tech. Bull. 158. For sale by the Supt. of Documents, Gov. Printing Office, Washington, D. C., at 10 cents per copy.

TABLE 1

CLASSIFICATION OF COMPARATIVE TERMS USED IN DESCRIBING THE PROPERTIES[1] OF THE VARIOUS SPECIES

Index figure	Specific gravity[2] or weight: Classification limits	Specific gravity or weight: Descriptive terms	Shrinkage: Classification limits	Shrinkage: Descriptive terms	Bending and compressive strength — Classification limits: Bending strength	Compressive strength	Combined bending and compressive strength	Bending and compressive strength: Descriptive terms
1	Below 0.20	Extremely light	Below 53	Extremely small	Below 29	Below 36	Below 40	Extremely weak
2	From .20 to 0.25	Exceedingly light	From 53 to 66	Exceedingly small	From 29 to 38	From 36 to 44	From 40 to 50	Exceedingly weak
3	From .25 to .30	Very light	From 66 to 80	Very small	From 38 to 48	From 44 to 53	From 50 to 60	Very weak
4	From .30 to .36	Light	From 80 to 95	Small	From 48 to 60	From 53 to 64	From 60 to 72	Weak
5	From .36 to .42	Moderately light	From 95 to 111	Moderately small	From 60 to 73	From 64 to 75	From 72 to 84	Moderately weak
6	From .42 to .50	Moderately heavy	From 111 to 132	Moderately large	From 73 to 91	From 75 to 89	From 84 to 100	Moderately strong
7	From .50 to .60	Heavy	From 132 to 159	Large	From 91 to 114	From 89 to 107	From 100 to 120	Strong
8	From .60 to .72	Very heavy	From 159 to 191	Very large	From 114 to 143	From 107 to 128	From 120 to 144	Very strong
9	From .72 to .86	Exceedingly heavy	From 191 to 228	Exceedingly large	From 143 to 179	From 128 to 153	From 144 to 172	Exceedingly strong
10	Above .86	Extremely heavy	Above 228	Extremely large	Above 153	Above 153	Above 172	Extremely strong

Index figure	Hardness: Classification limits	Hardness: Descriptive terms	Shock resistance: Classification limits	Shock resistance: Descriptive terms	Stiffness: Classification limits	Stiffness: Descriptive terms
1	Below 7.7	Extremely soft	Below 18	Extremely low	Below 60	Extremely limber
2	From 7.7 to 13.5	Exceedingly soft	From 18 to 28	Exceedingly low	From 60 to 75	Exceedingly limber
3	From 13.5 to 21	Very soft	From 28 to 40	Very low	From 75 to 90	Very limber
4	From 21 to 34	Soft	From 40 to 58	Low	From 90 to 108	Limber
5	From 34 to 50	Moderately soft	From 58 to 79	Moderately low	From 108 to 126	Moderately limber
6	From 50 to 76	Moderately hard	From 79 to 111	Moderately high	From 126 to 150	Moderately stiff
7	From 76 to 120	Hard	From 111 to 160	High	From 150 to 180	Stiff
8	From 120 to 190	Very hard	From 160 to 230	Very high	From 180 to 216	Very stiff
9	From 190 to 295	Exceedingly hard	From 230 to 329	Exceedingly high	From 216 to 258	Exceedingly stiff
10	Above 295	Extremely hard	Above 329	Extremely high	Above 258	Extremely stiff

[1]Formulae showing relation of other properties shown in table to specific gravity (G):

Shrinkage	$265G$
Bending strength	$216G^{5/4}$
Compressive strength (endwise)	$178G$
Combined bending and compressive strength	$200G$
Hardness	$430G^{2.5}$
Shock resistance	$445G^2$
Stiffness	$300G$

For reduction and weighing factors see Table 4, U. S. Dept. Agri. Tech. Bul. 158.

[2]The specific gravity is based on oven-dry weight and volume when green.

TABLE 2

PROPERTIES OF WOODS GROWN IN THE UNITED STATES AS

Common and botanical name	Number of trees tested	Specific gravity oven-dry based on green volume	Density or weight	Shrinkage from green to oven-dry condition based on dimension when green (volumetric)		Bending strength	
			Descriptive term	Comparative figure	Descriptive term	Comparative figure	Descriptive term
HARDWOODS							
Alder, red (Alnus rubra)	6	0.37	M L	123	M L	76	M S
Apple (Malus rumila var.)	10	.61	V H	170	V L	85	M S
Ash, Biltmore white (Fraxinus biltmoreana)	5	.51	H	121	M L	107	S
Ash, black (Fraxinus nigra)	11	.46	M H	144	L	77	M S
Ash, blue (Fraxinus quadrangulata)	5	.53	H	113	M L	109	S
Ash, green (Fraxinus pennsylvanica lanceolata)	10	.53	H	122	M L	107	S
Ash, Oregon (Fraxinus oregona)	3	.50	H	129	M L	88	M S
Ash, pumpkin (Fraxinus profunda)	3	.48	M H	113	M L	86	M S
Ash, white (Fraxinus americana)	23	.55	H	132	L	113	S
Ashes, commercial white (ave. of 4 species)	43	.54	H	126	M L	110	S
Aspen (Populus tremuloides)	11	.35	L	111	M L	63	M W
Aspen, largetooth (Populus grandidentata)	10	.35	L	116	M L	66	M W
Basswood (Tilia glabra)	8	.32	L	158	L	61	M W
Beech (Fagus grandifolia)	17	.56	H	162	V L	102	S
Beech, blue (Carpinus caroliniana)	12	.58	H	184	V L	76	M S
Birch, Alaska white (Betula neoalaskana)	10	.49	M H	166	V L	89	M S
Birch, gray (Betula populifolia)	5	.45	M H	147	L	61	M W
Birch, paper (Betula papyrifera)	10	.48	M H	158	L	78	M S
Birch, sweet (Betula lenta)	10	.60	V H	154	L	117	V S
Birch, yellow (Betula lutea)	17	.55	H	166	V L	106	S
Blackwood, (Avicennia nitida)	6	.83	EXC H	157	L	123	V S
Buckeye, yellow (Aesculus octandra)	5	.33	L	118	M L	58	W
Bustic (Dipholis salicifolia)	1	.86	EXT H	---	---	---	---
Butternut (Juglans cinerea)	10	.36	M L	100	M S	64	M W
Buttonwood (Conocarpus erecta)	7	.69	V H	144	L	89	M S
Cascara (Rhamnus purshiana)	5	.50	H	77	V S	71	M W
Catalpa, hardy (Catalpa speciosa)	15	.38	M L	73	V S	63	M W
Cherry, black (Prunus serotina)	5	.47	M H	113	M L	93	S
Cherry, pin (Prunus pennsylvanica)	5	.36	M L	129	M L	62	M W
Chestnut (Castanea dentata)	10	.40	M L	111	M L	68	M W
Chinquapin, golden)Castanopsis chrysophylla)	5	.42	M H	128	M L	83	M S
Cottonwood, northern black (Populus trichocarpa hastata)	5	.32	L	123	M L	60	M W
Cottonwood, eastern (Populus deltoides)	5	.37	M L	138	L	62	M W
Dogwood (Cornus florida)	5	.64	V H	194	EXC L	100	S
Dogwood, Pacific (Cornus nuttallii)	5	.58	H	168	V L	86	M S
Elder, blueberry (Sambucus coerulea)	5	.46	M H	149	L	72	M W
Elm, American (Ulmus americana)	12	.46	M H	145	L	85	M S
Elm, rock (Ulmus racemosa)	10	.57	H	137	L	106	S
Elm, slippery (Ulmus fulva)	6	.48	M H	138	L	92	S
Fig, golden (Ficus aurea)	1	.44	M H	---	----	61	M W
Gum, black (Nyssa sylvatica)	5	.46	M H	133	L	83	M S
Gum, blue (Eucalyptus globulus)	5	.62	V H	226	EXC L	134	V S
Gum, red (Liquidambar Styraciflua)	10	.44	M H	150	L	86	M S
Gum, tupelo (Nyssa aquatica)	6	.46	M H	122	M L	82	M S
Gumbo-limbo (Bursera simaruba)	5	.30	L	77	V S	39	V W
Hackberry (Celtis occidentalis)	6	.49	M H	138	L	76	M S
Haw, pear (Crataegus tomentosa)	2	.62	V H	---	----	95	S
Hickory, bigleaf shagbark (Hicoria laciniosa)	19	.62	V H	195	EXC L	126	V S
Hickory, bitternut (Hicoria cordiformis)	11	.60	V H	---	----	127	V S
Hickory, mockernut (Hicoria alba)	19	.64	V H	182	V L	135	V S
Hickory, nutmeg (Hicoria myristicaeformis)	5	.56	H	---	----	111	S
Hickory, pignut (Hicoria glabra)	60	.66	V H	182	V L	144	EXC S
Hickory, shagbark (Hicoria ovata)	24	.64	V H	170	V L	133	V S
Hickory, water (Hicoria aquatica)	2	.61	V H	---	----	128	V S
Hickories, pecan (ave. of 4 species)	23	.59	H	137	L	120	V S
Hickories, true (ave. of 4 species)	122	.65	V H	182	V L	138	V S
Hickories, pecan and true (ave. of 8 species)	145	.64	V H	180	V L	135	V S
Holly (Ilex opaca)	5	.50	H	155	L	76	M S
Hop-hornbeam (Ostrya virginiana)	5	.63	V H	183	V L	101	S
Inkwood (Exothea paniculata)	2	.73	EXC H	184	V L	124	V S

REPRESENTED BY COMPARATIVE FIGURES AND DESCRIPTIVE TERMS

Compressive strength (endwise)		Composite bending and compressive strength		Stiffness		Hardness		Shock resistance	
Comparative figure	Descriptive term	Comparative figure	Descriptive term	Comparative figure	Descriptive term	Comparative figure	Descriptive term	Comparative figure	Descriptive term
82	M S	79	M W	139	M S	48	M S	71	M L
75	M S	81	M W	139	M S	119	H	146	H
108	V S	107	S	156	S	104	H	114	H
68	M W	73	M W	126	M S	64	M H	122	H
107	V S	108	S	139	M S	119	H	147	H
106	S	107	S	157	S	107	H	116	H
88	M S	88	M S	143	M S	94	H	123	H
85	M S	[illegible]	M S	118	M L	103	H	87	M H
106	S	110	S	168	S	107	H	153	H
106	S	109	S	161	S	108	H	139	H
58	W	61	W	107	L	31	S	67	M L
69	M W	67	W	130	M S	38	M S	63	M L
62	W	61	W	126	M S	31	S	54	L
94	S	99	M S	169	S	96	H	135	H
66	M W	72	M W	114	M L	116	H	296	EXC H
86	M S	58	M S	161	S	61	M H	126	H
53	W	57	V W	85	V L	54	M H	147	H
66	M W	74	M W	137	M S	58	M H	158	H
105	S	112	S	207	V S	104	H	159	H
98	S	[illegible]	S	174	S	86	H	171	V H
120	V S	[illegible]	V S	185	V S	185	V H	167	V H
56	W	57	V W	112	M L	31	S	52	L
---	---	---	---	---	---	---	---	---	---
68	M W	66	W	115	M L	40	M S	80	M H
106	S	96	M S	159	S	122	V H	78	M L
79	M S	75	M W	93	L	86	H	140	H
60	W	62	W	110	M L	43	M S	95	M H
100	S	96	M S	150	S	72	M H	112	H
63	W	63	W	117	M L	41	M S	77	M L
70	M W	68	W	112	M L	50	M H	69	M L
76	M S	80	M W	125	M L	62	M H	95	M H
61	W	61	W	119	M L	29	S	59	M L
64	M W	63	W	123	M L	36	M S	73	M L
[illegible]	S	100	S	124	M L	154	V H	192	V H
95	S	69	M S	142	M S	116	H	154	H
76	M S	74	M W	115	M L	68	M H	109	M H
74	M W	80	M W	130	M S	66	M H	123	H
97	S	102	S	148	M S	104	H	189	V H
89	S	91	M S	140	M S	72	M H	162	V H
66	M W	63	W	67	EXC L	---	---	65	M L
78	M S	81	M W	118	M L	78	H	80	M H
148	EXC S	140	V S	233	EXC S	132	V H	134	H
77	M S	82	M W	134	M S	60	M H	99	M H
87	M S	84	M S	127	M S	78	H	81	M H
38	EXC W	39	EXT W	66	EXC L	30	S	32	V L
72	M W	74	M W	108	M L	74	M H	145	H
87	M S	92	M S	107	L	127	V H	193	V H
105	S	118	S	165	S	---	---	308	EXC H
127	V S	127	V S	170	S	---	---	227	V H
122	V S	130	V S	185	V S	---	---	270	EXC H
104	S	108	S	147	M S	---	---	221	V H
129	EXC S	138	V S	198	V S	---	---	308	EXC H
123	V S	129	V S	185	V S	---	---	258	EXC H
116	V S	122	V S	185	V S	---	---	189	V H
116	V S	118	S	165	S	142	V H	207	V H
123	V S	132	V S	188	V S	---	---	292	EXC H
122	V S	130	V S	184	V S	142	V H	279	EXC H
71	M W	74	M W	102	L	86	H	124	H
100	S	101	S	150	S	126	V H	169	V H
110	V S	118	S	182	V S	181	V H	154	H

Sheet No. 1

Common and botanical name	Number of trees tested	Specific gravity oven-dry based on green volume	Density or weight: Descriptive term	Shrinkage from green to oven-dry condition based on dimension when green (volumetric): Comparative figure	Shrinkage: Descriptive term	Bending strength: Comparative figure	Bending strength: Descriptive term
HARDWOODS (Continued)							
Ironwood, black (Krugiodendron ferreum)	4	1.04	EXT H	125	M L	157	EXC S
Laurel, California (Umbellularia californica)	5	.51	H	116	M L	72	M W
Laurel, mountain (Kalmia latifolia)	5	.62	V H	144	L	97	S
Locust, black (Robinia pseudoacacia)	3	.66	V H	103	M S	157	EXC S
Locust, honey (Gleditsia triacanthos)	6	.60	V H	107	M S	112	S
Madrono, Pacific (Arbutus menziesii)	6	.58	H	173	V L	86	M S
Magnolia, cucumber (Magnolia acuminata)	5	.44	M H	137	L	90	M S
Magnolia, evergreen (Magnolia grandiflora)	2	.46	M H	122	M L	81	M S
Magnolia, mountain (Magnolia fraseri)	5	.40	M L	126	M L	76	M S
Mangrove (Rhizophora mangle)	4	.89	EXT H	123	M L	176	EXC S
Maple, bigleaf (Acer macrophyllum)	5	.44	M H	113	M L	83	M S
Maple, black (Acer nigrum)	1	.52	H	140	L	93	S
Maple, red (Acer rubrum)	14	.49	M H	128	M L	93	S
Maple, silver (Acer saccharinum)	5	.44	M H	114	M L	69	M W
Maple, striped (Acer pennsylvanicum)	4	.44	M H	121	M L	78	M S
Maple, sugar (Acer saccharum)	22	.57	H	147	L	114	V S
Mastic (Sideroxylon foetidissimum)	5	.89	EXT H	123	M L	112	S
Oak, black (Quercus velutina)	8	.56	H	142	L	98	S
Oak, bur (Quercus macrocarpa)	5	.58	H	129	M L	82	M S
Oak, California black (Quercus kelloggii)	10	.51	H	115	M L	69	M W
Oak, canyon live (Quercus chrysolepis)	3	.70	V H	158	L	110	S
Oak, chestnut (Quercus montana)	5	.57	H	162	V L	102	S
Oak, laurel (Quercus laurifolia)	5	.56	H	173	V L	94	S
Oak, live (Quercus virginiana)	5	.81	EXC H	152	L	142	V S
Oak, Oregon white (Quercus garryana)	10	.64	V H	133	L	86	M S
Oak, pin (Quercus palustris)	5	.58	H	143	L	96	S
Oak, post (Quercus stellata)	10	.60	V H	159	V L	99	S
Oak, red (Quercus borealis)	33	.56	H	131	M L	99	S
Oak, Rocky Mountain white (Quercus utahensis)	3	.62	V H	121	M L	70	M W
Oak, scarlet (Quercus coccinea)	5	.60	V H	140	L	115	V S
Oak, southern red (Quercus rubra)	4	.52	H	153	L	83	M S
Oak, swamp red (Quercus rubra pagodaefolia)	3	.61	V H	163	V L	131	V S
Oak, swamp chestnut (Quercus prinus)	4	.60	V H	180	V L	100	S
Oak, swamp white (Quercus bicolor)	1	.64	V H	172	V L	122	V S
Oak, water (Quercus nigra)	5	.56	H	154	L	110	S
Oak, white (Quercus alba)	20	.60	V H	153	L	102	S
Oak, willow (Quercus phellos)	2	.56	H	175	V L	96	S
Oak, commercial red (ave. of 9 species)	70	.56	H	143	L	101	S
Oak, commercial white (ave. of 6 species)	45	.59	H	155	L	99	S
Oak, commercial red and white (ave. of 15 species)	115	.57	H	148	L	100	S
Osage-orange (Toxylon pomiferum)	1	.76	EXC H	89	S	---	---
Palmetto, cabbage (Sabal palmetto)	5	.37	M L	250	EXT L	40	V W
Paradise-tree (Simarouba glauca)	4	.33	L	82	S	42	V W
Pecan (Hicoria pecan)	5	.60	V H	137	L	110	S
Persimmon (Diospyros virginiana)	5	.64	V H	183	V L	122	V S
Pigeon-plum (Coccolobis laurifolia)	5	.77	EXC H	145	L	108	S
Poisonwood (Metopium toxiferum)	4	.51	H	115	M L	69	M W
Poplar, balsam (Populus balsamifera)	10	.30	L	104	M S	48	W
Poplar, yellow (Liriodendron tulipifera)	11	.38	M L	119	M L	71	M W
Rhododendron, great (Rhododendron maximum)	5	.50	H	158	L	85	M S
Sassafras (Sassafras variifolium)	5	.42	M H	103	M S	71	M W
Serviceberry (Amelanchier canadensis)	5	.66	V H	183	V L	121	V S
Silverbell (Halesia carolina)	5	.42	M H	122	M L	74	M S
Sourwood (Oxydendrum arboreum)	5	.50	H	152	L	94	S
Stopper, red (Eugenia confusa)	3	.83	EXC H	140	L	145	EXC S
Sugarberry (Celtis laevigata)	5	.47	M H	126	M L	74	M S
Sumach, staghorn (Rhus hirta)	5	.45	M H	---	---	74	M S
Sycamore (Platanus occidentalis)	10	.46	M H	136	L	74	M S
Walnut, black (Juglans nigra)	5	.51	H	116	M L	111	S
Walnut, little (Juglans rupestris)	1	.53	H	101	M S	91	S
Willow, black (Salix nigra)	10	.34	L	126	M L	45	V W
Willow, western black (Salix lasiandra)	5	.39	M L	132	L	67	M W
Witch-hazel (Hamamelis virginiana)	5	.56	H	188	V L	108	S

Comparative strength (endwise)		Composite bending and compressive strength		Stiffness		Hardness		Shock resistance	
Comparative figure	Descriptive term	Comparative figure	Descriptive term	Comparative figure	Descriptive term	Comparative figure	Descriptive term	Comparative figure	Descriptive term
168	EXT S	161	EXC S	254	EXC S	---	----	130	H
76	M S	73	M W	89	V L	106	H	144	H
100	S	98	M S	110	M L	143	V H	113	H
168	EXT S	162	EXC S	220	EXC S	161	V H	170	V H
111	V S	111	S	153	S	155	V H	144	H
88	M S	87	M S	117	M L	114	H	93	M H
88	M S	89	M S	175	S	57	M H	103	M H
73	M W	77	M W	136	M S	80	H	141	H
73	M W	75	M W	142	M S	51	M H	81	M H
155	EXT S	166	EXC S	270	EXT S	251	EXC H	164	V H
86	M S	84	M S	132	M S	73	M H	78	M L
89	S	91	M S	149	M S	97	H	135	H
87	M S	90	M S	158	S	79	H	110	M H
71	M W	70	W	106	L	65	M H	93	M H
73	M W	76	M W	135	M S	59	M H	100	M H
106	S	111	S	178	S	115	H	138	H
125	V S	118	S	183	V S	208	EXC H	97	M H
91	S	95	M S	146	M S	102	H	128	H
81	M S	82	M W	104	L	112	H	114	H
72	M W	70	W	95	L	99	H	76	M L
127	V S	117	S	159	S	181	V H	131	H
94	S	98	M S	166	S	90	H	107	M H
90	S	92	M S	169	S	99	H	120	H
130	EXC S	137	V S	228	EXC S	240	EXC H	148	H
89	S	87	M S	107	L	153	V H	127	H
95	S	96	M S	167	S	111	H	152	H
89	S	95	M S	143	M S	122	V H	130	H
88	M S	94	M S	164	S	103	H	143	H
67	M W	68	W	78	V L	137	V H	137	H
107	V S	112	S	181	V S	120	V H	175	V H
76	M S	80	M W	153	S	86	H	83	M H
122	V S	127	V S	215	V S	123	V H	162	V H
95	S	98	M S	171	S	103	H	132	H
114	V S	119	S	184	V S	122	V H	165	V H
95	S	104	S	196	V S	101	H	138	H
96	S	99	M S	152	S	108	H	127	H
86	M S	92	M S	167	S	106	H	116	H
92	S	97	M S	168	S	103	H	139	H
93	S	96	M S	149	M S	109	H	125	H
92	S	97	M S	161	S	105	H	134	H
---	---	---	---	---	---	---	---	---	---
36	EXC W	38	EXT W	55	EXT L	21	S	49	L
44	V W	43	EXC W	86	V L	32	S	21	EXC L
104	S	108	S	162	S	142	V H	156	H
116	V S	119	S	172	S	162	V H	136	H
118	V S	112	S	184	V S	189	V H	114	H
57	W	64	W	99	L	62	M H	49	L
48	V W	48	EXC W	95	L	25	S	43	L
68	M W	70	W	135	M S	40	M S	58	M L
91	S	88	M S	100	L	104	H	104	M H
71	M W	71	W	103	L	60	M H	98	M H
116	V S	119	S	181	V S	131	V H	186	V H
72	M W	73	M W	133	M S	53	M H	81	M H
87	M S	91	M S	169	S	83	H	108	M H
137	EXC S	142	V S	197	V S	---	---	162	V H
74	M W	74	M W	103	L	63	H	116	H
76	M S	75	M W	94	L	64	M H	116	H
76	M S	75	M W	129	M S	64	M H	78	M L
113	V S	112	S	167	S	88	H	124	H
86	M S	90	M S	118	M L	---	---	126	H
41	EXC W	43	EXC W	70	EXC L	35	M S	91	M H
63	W	65	W	127	M S	50	M H	104	H
88	M S	100	S	129	M S	107	H	187	V H

Common and botanical name	Number of trees tested	Specific gravity oven-dry based on green volume	Density or weight: Descriptive term	Shrinkage from green to oven-dry condition based on dimension when green (volumetric): Comparative figure	Shrinkage: Descriptive term	Bending strength: Comparative figure	Bending strength: Descriptive term
SOFTWOODS							
Cedar, Alaska (Chamaecyparis nootkatensis)	[illegible]	0.42	M H	91	S	80	M S
Cedar, incense (Libocedrus decurrens)	8	.35	L	81	S	70	M W
Cedar, Port Orford (Chamaecyparis lawsoniana)	14	.40	M L	106	M S	82	M S
Cedar, eastern red (Juniperus virginiana)	5	.44	M H	78	V S	67	M W
Cedar, western red (Thuja plicata)	15	.31	L	76	V S	60	M W
Cedar, northern white (Thuja occidentalis)	5	.29	V L	69	V S	50	W
Cedar, southern white (Chamaecyparis thyoides)	10	.31	L	83	S	53	W
Cypress, southern (Taxodium distichum)	26	.42	M H	104	M S	79	M S
Douglas fir (Pseudotsuga taxifolia) (coast type)	34	.45	M H	121	M L	90	M S
Douglas fir (Pseudotsuga taxifolia) (Intermediate type)	10	.41	M L	112	M L	80	M S
Douglas fir (Pseudotsuga taxifolia) (Rocky Mountain type)	10	.40	M L	103	M S	75	M S
Fir, Alpine (Abies lasiocarpa)	5	.31	L	92	S	51	W
Fir, balsam (Abies balsamea)	5	.34	L	103	M S	59	W
Fir, corkbark (Abies arizonica)	10	.28	V L	90	S	51	W
Fir, lowland white (Abies grandis)	10	.37	M L	105	M S	72	M W
Fir, noble (Abies nobilis)	9	.35	L	126	M L	74	M S
Fir, California red (Abies magnifica)	5	.37	M L	114	M L	78	M S
Fir, silver (Abies amabilis)	6	.35	L	142	L	70	M W
Fir, white (Abies concolor)	20	.35	L	95	M S	72	M W
Fir, white (ave. of 4 species)	45	.35	L	110	M S	72	M W
Hemlock, eastern (Tsuga canadensis)	20	.38	M L	98	M S	72	M W
Hemlock, mountain (Tsuga mertensiana)	10	.43	M H	114	M L	81	M S
Hemlock, western (Tsuga heterophylla)	18	.38	M L	120	M L	74	M S
Juniper, alligator (Juniperus pachyphloea)	3	.48	M H	73	V S	63	M W
Larch, western (Larix occidentalis)	13	.48	M H	129	M L	89	M S
Pine, jack (Pinus banksiana)	5	.39	M L	102	M S	64	M W
Pine, jeffrey (Pinus jeffreyi)	5	.37	M L	103	M S	68	M W
Pine, limber (Pinus flexilis)	2	.37	M L	80	S	69	M W
Pine, loblolly (Pinus taeda)	10	.50	H	127	M L	93	S
Pine, lodgepole (Pinus contorta)	28	.38	M L	114	M L	67	M W
Pine, longleaf (Pinus palustris)	34	.55	H	124	M L	106	S
Pine, mountain (Pinus pungens)	5	.49	M H	107	M S	91	S
Pine, northern white (Pinus strobus)	18	.34	L	83	S	63	M W
Pine, Norway (Pinus resinosa)	5	.44	M H	116	M L	85	M S
Pine, pitch (Pinus rigida)	10	.45	M H	110	M S	80	M S
Pine, pond (Pinus rigida serotina)	5	.50	H	115	M L	89	M S
Pine, ponderosa (Pinus ponderosa)	31	.38	M L	97	M S	65	M W
Pine, sand (Pinus clausa)	5	.45	M H	104	M S	86	M S
Pine, shortleaf (Pinus echinata)	12	.49	M H	128	M L	97	S
Pine, slash (Pinus caribaea)	10	.64	V H	131	M L	116	V S
Pine, sugar (Pinus lambertiana)	9	.35	L	79	V S	64	M W
Pine, western white (Pinus monticola)	14	.36	M L	118	M L	69	M W
Pinon (Pinus edulis)	3	.50	H	99	M S	60	M W
Redwood (Sequoia sempervirens)	16	.39	M L	67	V S	83	M S
Spruce, black (Picea mariana)	5	.38	M L	112	M L	68	M W
Spruce, Engelmann (Picea engelmannii)	10	.31	L	102	M S	55	W
Spruce, red (Picea rubra)	11	.38	M L	117	M L	72	M W
Spruce, Sitka (Picea sitchensis)	25	.37	M L	116	M L	72	M W
Spruce, white (Picea glauca)	15	.37	M L	134	L	68	M W
Spruces, (ave. of red, white, and Sitka)	51	.37	M L	121	M L	71	M W
Tamarack, (Larix laricina)	5	.49	M H	128	M L	84	M S
Yew, Pacific (Taxus brevifolia)	5	.60	V H	96	M S	115	V S

Compressive strength (endwise)		Composite bending and compressive strength		Stiffness		Hardness		Shock resistance	
Comparative figure	Descriptive term	Comparative figure	Descriptive term	Comparative figure	Descriptive term	Comparative figure	Descriptive term	Comparative figure	Descriptive term
87	M S	83	M W	136	M S	53	M H	93	M H
81	M S	74	M W	97	L	47	M S	53	L
90	S	85	M S	168	S	48	M S	79	M H
87	M S	74	M W	80	V L	81	H	114	H
74	M W	66	W	108	M L	38	M S	52	L
52	V W	51	V W	78	V L	30	S	47	L
61	W	56	V W	93	L	35	M S	51	L
92	S	84	M S	136	M S	52	M H	76	M L
107	V S	94	M S	181	V S	59	M H	81	M H
90	S	85	M S	159	S	58	M H	72	M L
83	M S	79	M W	142	M S	52	M H	67	M L
57	W	54	V W	94	L	33	S	36	V L
67	M W	62	W	118	M L	31	S	50	L
57	W	53	V W	104	L	27	S	38	V L
82	M S	76	M W	156	S	43	M S	72	M L
76	M S	75	M W	150	S	39	M S	68	M L
74	M W	76	M W	134	M S	52	M H	71	M L
76	M S	73	M W	147	M S	37	M S	70	M L
73	M W	72	M W	127	M S	42	M S	60	M L
76	M S	74	M W	141	M S	41	M S	66	M L
79	M S	75	M W	121	M L	51	M H	67	M L
88	M S	84	M S	131	M S	64	M H	99	M H
84	M S	78	M W	144	M S	50	M H	73	M L
76	M S	68	W	60	EXC L	107	H	79	M H
104	S	95	M S	153	S	64	M H	81	M H
73	M W	68	W	111	M L	48	M S	78	M L
71	M W	70	W	116	M L	44	M S	63	M L
69	M W	69	W	107	L	39	M S	54	L
104	S	98	M S	166	S	62	M H	93	M H
74	M W	70	W	128	M S	41	M S	60	M L
123	V S	113	S	189	V S	76	H	103	M H
93	S	92	M S	151	S	64	M H	92	M H
67	M W	65	W	119	M L	35	M S	55	L
91	S	88	M S	163	S	46	M S	84	M H
76	M S	78	M W	146	M S	56	M H	96	M H
103	S	95	M S	154	S	64	M H	90	M H
69	M W	67	W	112	M L	41	M S	58	M L
89	S	87	M S	135	M S	63	M H	86	M H
104	S	100	S	170	S	68	M H	111	H
126	V S	120	V S	195	V S	93	H	105	M H
68	M W	66	W	112	M L	38	M S	55	L
75	M S	71	W	137	M S	35	M S	65	M L
75	M S	65	W	108	M L	73	M H	65	M L
103	S	91	M S	137	M S	54	M H	65	M L
70	M W	69	W	143	M S	40	M S	82	M H
57	W	56	V W	100	L	32	S	45	L
83	M S	75	M W	138	M S	41	M S	68	M L
75	M S	73	M W	144	M S	44	M S	76	M L
70	M W	69	W	123	M L	37	M S	67	M L
74	M W	72	M W	136	M S	42	M S	71	M L
96	S	89	M S	147	M S	53	M H	85	M H
112	V S	114	S	121	M L	138	V H	170	V H

FOREST SCHOOL STATISTICS FOR 1937: DEGREES GRANTED AND ENROLLMENTS

By CEDRIC H. GUISE

Cornell University

Every member of staff of forest schools and every forestry student should read the following article by Professor Guise. The enrollment in forestry has increased tremendously during the past few years, reaching an all time high of 6,067 in 1937. However, in 1937 the registration in the freshman class was considerably lower than that of the previous year. There are indications that the peak registration in forestry has been reached but that the number of graduates will continue to be large for at least the next five years.

CONTINUING the practice started in 1933 of collecting and publishing annually the forest school statistics of enrollments and numbers of degrees conferred for studies completed in professional forestry, the following report is issued. Supplementing the material published as a result of the Forest Education Inquiry, 1929-1931, these annual presentations show current trends as well as all available statistics for the period 1900 to 1937. For detailed analyses and comparisons, the references cited in the footnote should be consulted.[1]

In the present article there is shown for each forest school in the United States the numbers of degrees granted for the calendar year 1937, and the enrollments for the first term of the academic year 1937-38.

In addition for purposes of comparison and analysis, the annual statistics for all schools for the period 1900 to 1937 are also tabulated. Current trends in enrollments by classes are given for the period 1929 to 1937.

Degrees Granted

In Table 1 are shown for each of the forest schools in the United States the numbers of undergraduate, Master's and Doctor's degrees conferred for completion of studies in forestry in 1937. Iowa reported seven undergraduate degrees granted in December, 1936. This number is not included in the figures in Table 1. For 1937 there were reported 777 undergraduate degrees, 75 Master's degrees and seven Doctor's degrees.

In Table 2 are presented for each of the years 1900 to 1937 inclusive, the total numbers of undergraduate and Master's degrees reported from all schools. A comparable table in last year's report listed 495 undergraduate degrees for 1936. This figure has been increased to 502, in order to include the seven degrees from Iowa, granted in December, 1936. The 777 undergraduate degrees for 1937 represents an increase of 275 degrees over the 502 for the year 1936, and is by far the largest number ever reported. This number of 275 represents an increase of 55

[1]Graves, H. S. and C. H. Guise. Forest education. Yale Univ. Press. 1932.

Guise, C. H. Degrees granted, enrollments and recent developments at the forest schools in the United States, 1931-1933. Jour. For. 32:337-343. 1934.

———. Forest school statistics for 1934: Degrees granted and enrollments. Jour. For. 33:402-405. 1935.

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———. Forest school statistics for 1936: Degrees granted and enrollments. Jour. For. 35:77-83. 1937.

per cent over the number in the preceding year. The average for the years 1929 to 1934 inclusive was 344. The actual increases in numbers over this average for the years 1935, 1936 and 1937 are respectively 79, 158 and 433, which in terms of percentages, using 344 as a base, are 23, 46 and 125.

The numbers did not fluctuate materially between the years 1928 and 1934, but for each of the past three years the successive increases have been pronounced, being 86 in 1935, 79 in 1936, and as noted, 275 in 1937. In last year's report it was stated that the number for 1937 would be far beyond those reported through 1936. This prediction, which required no special foresight, has been substantiated. For 1938 this number may reach 900 or more. When the decline will set in is not exactly certain, but probably not before 1939 or 1940. Even when this decline starts, the actual numbers are certain to continue at a high level for some five or six, possibly ten, years more. Much depends on placement opportunities in forestry and its allied lines. The total number of undergraduate degrees reported from the forest schools through 1937 is 7,003.

The number of Master's degrees for 1937 is reported as 75, an increase of only 8 over the 67 for 1936. This number 75 has been exceeded, in both 1931 and 1932, when 97 and 78 Master's degrees were listed for those respective years. It is however the largest number reported since 1933. In all a total of 1,567 Master's degrees have been granted between the years 1900 and 1937.

In 1937, seven Doctor's degrees were reported from six schools. This figure brings the total number of Doctorates granted for work in forestry and its

TABLE 1

NUMBER OF DEGREES GRANTED FOR COMPLETION OF STUDIES AT FOREST SCHOOLS IN THE UNITED STATES FOR THE CALENDAR YEAR 1937

Forest school	Undergraduate degrees	Master's degrees	Doctor's degrees
1. California	63	5	1
2. Colorado State	49	–	–
3. Connecticut	10	–	–
4. Cornell	1	4	2
5. Duke	–	1	–
6. Georgia	31	2	–
7. Harvard	–	2	–
8. Idaho	37	2	–
9. Iowa	26	2	–
10. Louisiana	23	2	–
11. Maine	24	–	–
12. Michigan State	35	–	1
13. Michigan University	53	15	1
14. Minnesota	56	4	1
15. Montana	17	–	–
16. New Hampshire	14	–	–
17. N. Y. State College of Forestry	93	11	1
18. North Carolina	29	1	–
19. Oregon State	41	2	–
20. Pennsylvania State	59	–	–
21. Purdue	14	–	–
22. Utah	52	–	–
23. Washington State	13	–	–
24. Washington University	37	1	–
25. Yale	–	21	–
Totals	777	75	7

underlying sciences to 77.

The New York State Ranger school granted certificates to 39 men in 1937. Added to the figures reported previously, the total number of certificates conferred for completion of the ranger school course of study is 583.

In discussions with forest school men the point has been raised that the mere presentation of the numbers of degrees is not a clear index to the situation which exists. It was suggested that some effort be made to determine the special fields in which concentration or specialization took place. For this reason, the questionnaire forms requested that the undergraduate degrees be classified, if possible, for studies completed in the fields of (1) silviculture and management, (2) utilization, and (3) other fields of concentration or specialization.

Of the 22 schools reporting, 15 made this classification. These schools reported 532 undergraduate degrees. Seven schools, reporting 245 degrees, either made no effort to classify the graduates as to fields of study or presented their figures in such a way that they could not be used.

The 532 men reported from the 15 schools were classified as follows: silviculture and management, 386 or 73 per cent; utilization, 48 or 9 per cent; and other fields of concentration or specialization, 98 or 18 per cent. These figures, while unsatisfactory, indicate to some extent the fields in which our forest school students are preparing themselves.

If the 245 degrees from the other seven schools were meant to be classified entirely in the silviculture and management group, and added to the 386 noted above, the following figures would result: silvi-

TABLE 2

NUMBER OF DEGREES GRANTED FOR COMPLETION OF STUDIES AT FOREST SCHOOLS IN THE UNITED STATES FOR THE CALENDAR YEARS 1900-1937

Years	Undergraduate degrees	Master's degrees
1900	1	–
1901	5	–
1902	2	9
1903	3	14
1904	9	29
1905	9	34
1906	24	24
1907	19	27
1908	31	35
1909	47	44
1910	61	48
1911	100	61
1912	122	54
1913	136	37
1914	151	42
1915	124	35
1916	151	36
1917	160	27
1918	65	10
1919	53	6
1920	160	25
1921	126	26
1922	141	44
1923	217	31
1924	215	43
1925	280	44
1926	259	58
1927	263	50
1928	302	64
1929	291	54
1930	308	69
1931	394	97
1932	380	78
1933	355	65
1934	337	47
1935	423	58
1936	502	67
1937	777	75
Totals	7,003	1,567

TABLE 3

UNDERGRADUATE ENROLLMENT AT FOREST SCHOOLS IN THE UNITED STATES, 1903-04 TO 1937-38

Year	Enrollment	Year	Enrollment
1903-04	19	1920-21	1,092
1904-05	39	1921-22	1,363
1905-06	51	1922-23	1,347
1906-07	98	1923-24	1,439
1907-08	143	1924-25	1,624
1908-09	258	1925-26	1,771
1909-10	357	1926-27	1,880
1910-11	518	1927-28	1,957
1911-12	591	1928-29	2,079
1912-13	637	1929-30	2,123
1913-14	868	1930-31	2,120
1914-15	904	1931-32	2,573
1915-16	944	1932-33	2,388
1916-17	897	1933-34	2,246
1917-18	560	1934-35	3,791
1918-19	498	1935-36	5,406
1919-20	927	1936-37	6,032
		1937-38	6,067

culture and management, 631 or 81 per cent; utilization, 48 or 6 per cent; and other fields, 98 or 13 per cent. The latter figures are presented, with a full realization that they may be, probably are, of little significance.

ENROLLMENTS

Enrollment trends for 1937 are of unusual interest. The total undergraduate enrollment for all schools in 1937 is 6,067, an increase of only 35 over the number reported for 1936. This figure of 6,067 is of course abnormally high for our schools of forestry, and in itself makes possible interesting comparisons with statistics of former years.

In Table 3 are the total annual undergraduate enrollments at all forest schools in the United States for the years 1903-04 to 1937-38 inclusive. As in former articles the writer has used as a base for comparison the arithmetic mean of the enrollments for the years 1929-30 to 1933-34; during this period the enrollments ranged between 2,120 and 2,573, and were unaffected by the conservation activities instituted at the start of the first Roosevelt administration. The mean was 2,244. It is worth while at this point to copy briefly from last year's report:

"In 1934-35 the enrollment was 3,791, an increase of 1,545 over that of 1933-34. In 1935-36, the number of undergraduates reported was 5,406, an increase over the previous year of 1,615; and in 1936-37, the enrollments are reported as 6,032, a further annual increase of 626. This current figure of 6,032 is 3,786 over the enrollment of 1933-34, and 3,788 more than the 5 year mean of 2,244 for the years 1929-30 and 1933-34."

The figure of 6,067, while only 35 more than the number for 1936, is still 3,823 more than the average of 2,244, an increase of 171 per cent. Undoubtedly this figure of 6,067 represents the high water mark in undergraduate forest school enrollments. Each of the next few years will see a successive decline, unless some unforeseen contingency develops. Under present day conditions the enrollments may be expected to diminish until a more normal and stabilized registration will result. The time required to reach such a status is not easy to predict, though certainly it will not be before five or more years have elapsed. Of course forest school men may justly take issue with the writer that we do not know what a normal enrollment should be. Possibly some think that the situation which exists is satisfactory and not a cause for uneasiness. But those charged with placing their graduates have no illusions as to its serious nature.

There has been some criticism of the use and emphasis of the total figures of undergraduate enrollment since they are made up in large part by men in the freshmen and sophomore classes. It is contended that men in these years are for the most part in classes which are not taught by the members of the forest school faculties, and that undue emphasis on their numbers gives a distorted picture of the real situation, in as far as it deals with the actual responsibilities of the forest school faculties. Of course some of this criticism is valid, but in general the forest school men should welcome a knowledge of the numbers of men who, with due allowance for mortality, are probable candidates for the upper two classes.

As important as is the figure of 6,067 it is of greater significance to see how this total is made up, and the way in which the trends in class enrollments are developing. These facts are evident upon study of Tables 4 and 5.

In Table 4 are shown the current enrollments by classes at each forest school. This table is of interest primarily in that it shows the comparative numbers of undergraduate and graduate students at-

tending each of the schools. The 11 special students listed for Louisiana are transfers who will be assigned regular standing upon the completion of a probationary period.

At this point might be mentioned the facts relative to enrollments of graduate students. Registered for the Master's degree are 150, practically the same as last year which was 151. For the Doctor's degree 34 candidates are reported, an increase of 6 over the 28 listed for 1936. As previously noted the division of graduate students into the categories of Master and Doctor is not too well defined in that some men registered for the Master's degree are also planning on becoming candidates for the doctorate. There is no duplication on these tables. The total number of candidates listed for advanced degrees in 1937 is 184. In 1936 it was 179; in 1935, 139; in 1934, 122; in 1933, 117; in 1932, 206; and in 1931, 199.

The New York State Ranger School reports 49 men registered at the start of the current year. In the ranger course at Pennsylvania State College there were also 49 men enrolled. Duke University reports 3 freshmen, 4 sophomores, 3 juniors, and 1 senior in the preforestry course. These men were not included in Table 4, inasmuch as professional instruction in forestry at this institution is planned for graduate years only.

Trends in enrollments for the last 9 years are shown in Table 5, which presents for each of the years 1929-30 to 1937-38, the undergraduate enrollments by classes for all forest schools, including the ratio of seniors to freshmen. It is in this table that extremely significant trends may be noted.

The current enrollment in the fresh-

TABLE 4

ENROLLMENT BY CLASSES AT FOREST SCHOOLS IN THE UNITED STATES—FIRST TERM 1937-38

	Forest school	Freshmen	Sophomores	Juniors	Seniors	Total undergraduates	Graduates Masters	Graduates Doctors	Special students
1.	California	53	64	124	87	328	18	12	—
2.	Colorado State	141	92	85	53	371	—	—	—
3.	Connecticut	7	7	3	10	27	1	—	—
4.	Duke	—	—	—	—	—	7	2	—
5.	Georgia	56	76	46	58	236	—	—	—
6.	Harvard	—	—	—	—	—	3	1	—
7.	Idaho	117	102	95	73	387	5	—	1
8.	Iowa	98	89	56	41	284	7	—	—
9.	Louisiana	60	45	36	25	166	—	—	11
10.	Maine	71	56	33	32	192	5	—	2
11.	Michigan State	104	95	84	63	346	3	—	—
12.	Michigan University	—	—	70	76	146	16	10	5
13.	Minnesota	146	127	112	73	458	3	4	5
14.	Montana	144	101	63	30	338	2	—	—
15.	New Hampshire	30	25	16	9	80	—	—	—
16.	N. Y. State Col. of Forestry	150	136	104	112	502	28*	—	—
17.	North Carolina	73	63	29	36	201	—	—	—
18.	Oregon State	158	163	100	67	488	9	—	—
19.	Pennsylvania State	114	134	84	81	413	1	—	1
20.	Purdue	73	35	32	23	163	—	—	—
21.	Utah	126	67	60	72	325	4	—	—
22.	Washington State	52	49	37	25	163	—	—	—
23.	Washington Univ.	146	130	109	68	453	5	2	3
24.	Yale	—	—	—	—	—	33	3	—
	Totals	1,919	1,656	1,378	1,114	6,067	150	34	28
	Numbers of schools	20	20	21	21	21	17	7	7

*Masters and Doctors.

man class is 1919. For the second successive year a decrease has taken place; the maximum number reported in the first-year class was 2,301 in 1935. Last year there was a decrease of 257 or 11 per cent; this year there was a still further drop of 125, which represents a decrease of 6 per cent from the previous year. This enrollment of 1,919 is however 1,146 or 148 per cent more than the five year mean of 773.

In the sophomore class, the enrollment for 1937 of 1,656 is 115 less than that of the preceding year, a drop of 7 per cent; it is 1,059 or 180 per cent higher than the five year mean of 597.

In the junior class the current registration of 1,378 also shows a slight decrease from last year. The actual drop is 24, or 1.7 per cent. This current figure is 902 or 190 per cent higher than the mean of 476 for the years 1929 to 1934. In the senior class, the 1937 enrollment of 1,114 exceeds that of 1936 by 299 or 36 per cent. This figure is 716 or 180 per cent more than the five year mean of 398.

Any one who is interested can draw his own conclusions. Disregarding the numbers in the first two classes it is apparent that our schools are going to graduate between 1,500 and 2,000 foresters in the next two years. A brief glance at Table 2 will show that these two years promise to produce more men with undergraduate degrees than did all of our schools for the period 1900 to 1922. The enrollments by classes for 1937-38 show clearly why abnormally large graduating classes may be expected for at least each of the next five years.

General

For purposes of information and record, the following notes are included:

All instruction in professional forestry at Cornell has been discontinued. Undergraduate instruction terminated in June, 1936; graduate instruction in June, 1937. General instruction in forestry for students in Agriculture and other colleges of the University, and extension activities are being continued.

Table 5

UNDERGRADUATE ENROLLMENT, BY CLASSES, AND RATIOS OF SENIORS TO FRESHMEN, IN FOREST SCHOOLS IN THE UNITED STATES FOR THE YEARS 1929-30 TO 1937-38

Academic year	—Enrollment— Freshmen	Sophomores	Juniors	Seniors	Total[1]	Ratios in per cent seniors to freshmen
1929-30	695	573	451	352	2,071	57
1930-31	620	565	434	377	1,998	60
1931-32	964	598	530	444	2,536	46
1932-33	811	619	497	448	2,375	55
1933-34[2]	775	628	467	368	2,235	58
1934-35[2]	1,751	930	671	439	3,791	25
1935-36[2]	2,301	1,587	943	575	5,406	25
1936-37[2]	2,044	1,771	1,402	815	6,032	40
1937-38[2]	1,919	1,656	1,378	1,114	6,067	58
Average 1929-34	773	597	476	398	2,244	51
Increase 1934-35	978	333	195	41	1,547	
Increase 1935-36	1,528	990	467	177	3,162	
Increase 1936-37	1,271	1,174	926	417	3,788	
Increase 1937-38	1,146	1,059	902	716	3,823	
Increase 1934-35 per cent	126	56	41	10	70	
Increase 1935-36 per cent	198	166	98	44	141	
Increase 1936-37 per cent	170	196	195	105	169	
Increase 1937-38 per cent	148	180	190	180	171	

[1]Special students excluded.
[2]First term enrollments.

The Department of Forestry at Iowa State College reports the acquisition of a 3,500 acre school forest, which is to be managed under the direction of the forest school faculty and serve as a unit for field operations and student instruction.

This school has also embarked upon a five-year course for students who wish to complete the essential requirements in forestry, and at the same time secure some specialization in closely allied lines. The following groups are now offered for first-year students:

- Forestry and Conservation
- Forestry and Economics
- Forestry and Wildlife Management
- Forestry and National Forest Range Management

Iowa also has effected an exchange fellowship in forestry with one of the German universities, starting in the fall of 1937.

Victor Beede, Professor of Forest Management, has been appointed to the headship of the Pennsylvania State Forest School, succeeding Professor J. A. Ferguson who retired at the close of the last academic year.

The College of Forestry at the University of Washington now has a teaching staff of 9 men who give full time to the technical subjects. At this college general courses in Wildlife Management, Range Management, Range Plants and Recreation have been added to the list of subjects offered to forestry students.

The Department of Forestry at Colorado State College emphasizes the fact that the departmental staff gives no instruction to freshmen and sophomores, but confines its teaching work to the men in the two upper classes. At this school all men electing to specialize in forestry will attend the forestry summer camp of nine weeks prior to enrolling as juniors.

The School of Forestry at Oregon State College reports that the teaching staff has been increased by three men, starting in the fall of 1937. Plans are under way for the development of a five-year program leading to the degree Master of Forestry.

An interesting development in dealing with enrollments comes from the School of Forestry at Montana State University. Graduates of high schools from states other than Montana must be ranked in the upper half of their classes. This rule can not be applied to bona fide residents of the State of Montana; however, unless these resident students maintain their work at a satisfactory level established by the school, they are dropped for a year and not readmitted until they can raise their academic record to that which the school of forestry establishes as an essential minimum.

Definite academic standards also are set for those who wish to enter as transfer students, either from other institutions or other colleges at Montana State University. These men must have had records higher than average. The faculty of this school is to be commended in its efforts to approach a problem which all schools sooner or later will probably be forced to meet.

In this article which is essentially factual and objective in character there has been no attempt to comment on the problems which are created as a result of the enrollment trends and the large numbers of men being trained in forestry. Nevertheless these problems exist now and are certain to become increasingly acute. Plans for discussing these issues at the annual meeting of the Division of Education of the Society are already under way. It is to be hoped that constructive contributions may be forthcoming.

PROGRESS REPORT ON A SET OF SPRUCE THINNING PLOTS ESTABLISHED IN 1906 IN CORBIN PARK, N. H.

By ALBERT G. SNOW JR.[1]

Northeastern Forest Experiment Station[2]

Plots established in an old-field spruce stand in 1906 by the Forest Service, thinned in 1906, 1915, and 1935, and remeasured at periodic intervals, has yielded data of particular interest to owners of stands of this character. Analysis of the data indicates that thinning of old-field spruce stands is beneficial in several respects; by increasing the net annual increment; by providing for a cash income to the owner above the cost of thinning; by decreasing mortality; and by providing conditions conducive to the establishment of abundant coniferous reproduction.

IN 1906 the Forest Service established a set of plots in a well-stocked stand of old-field spruce growing on the lower west slope of Croyden Mountain in Corbin Park, N. H. The purpose of this study was to determine the effects of a moderate thinning on the future yield from this type of stand and on the subsequent development of reproduction. As these plots had been established 29 years at the time of the last remeasurement, the results secured are indicative of the trends to be expected when thinning operations are conducted in old-field spruce stands of this character.

Description of Plots

Two plots, each 0.2 acres in size, were established in a dense, healthy stand of old-field red spruce. This stand is located on land sloping gently to the west, with the plots at an elevation of approximately 1,450 feet. The soil is a light, sandy loam with an enriched top soil of 6 to 12 inches, with some clay in admixture, and numerous rocks scattered on the surface. At the time the plots were established, the trees averaged fifty-five years of age.

These plots, since their establishment in 1906, were remeasured in 1911, 1915, 1926, 1930, and in 1935. Permanent records were maintained for each tagged tree, and diameter breast height, crown class, and total height (for representative trees) were secured at each remeasurement. Observations were also made as to the species, height, and amount of reproduction. Intensive milacre strips were established in 1935.

Treatment

One of the plots (Plot B) was reserved intact as the control. The other (Plot A) was thinned three times—1906, 1915, and in 1935. In 1906, 20 per cent of the basal area of the stand was removed. The 1915 thinning removed an additional 33 per cent, and a further 20 per cent of the basal area was removed in 1935. The marking was confined principally to trees in the lower crown classes, which nominally constituted thinning from below. The status of Plot A before the 1935 thinning is pictured in Figure 1.

Results

The results of this experiment to date strongly indicate that thinning of old-field spruce stands is a practical operation. Increased yields, as a result of greater annual increment, is one of the benefits that may be expected. Another very desirable objective is accomplished by thinning, namely, securing an adequate stocking of coniferous reproduction before the stand is cut.

The data presented in this report substantiate those obtained in other inves-

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[1]The writer wishes to express his appreciation for the generous counsel and assistance of Marinus Westveld in the analysis of the data, and preparation of this manuscript.

[2]Maintained by the U. S. Department of Agriculture at New Haven, Conn., in cooperation with Yale University.

tigation.[3] Periodic changes in basal area and volume over a 29-year period are presented, which are indicative of the results to be expected from thinning operations after a long period of time has elapsed.

Basal Area Changes.—A considerable change in the distribution of diameter classes occurred between 1906 and 1935. The changes in diameter class distribution at each remeasurement period, based on per cent of the total basal area, are shown

Fig. 1.—Old-field spruce stand about 84 years old (Plot A) that was thinned in 1906 and 1915, indicating the healthy and vigorous condition of the plot in 1935. Light conditions are ideal for development of the coniferous reproduction already established.

[3]Hawley, Ralph C. Observations on thinning and management of eastern white pine in southern New Hampshire. Yale University, School of Forestry Bull. No. 42, 1936.

in Figure 2.

An interesting point brought out by this figure is that on the treated plot, all the trees in the smaller size classes (3-4" group) had either moved into a larger size class group, died, or been cut, 15 years sooner than the same size class group on the check plot. The trees on the unthinned plot were slower in growth in another respect; it took 29 years for 20 per cent of the basal area of the trees on this plot to become concentrated in the 10-14" group, while on the thinned plot, 20 per cent of the basal area was in this class 10 years after the plots were established. On the treated plot, over 60 per cent of the basal area was concentrated in the 10-14" group after 29 years.

Additional interesting information, when the basal area changes are examined from a quantitative standpoint, is brought out in Figure 3.

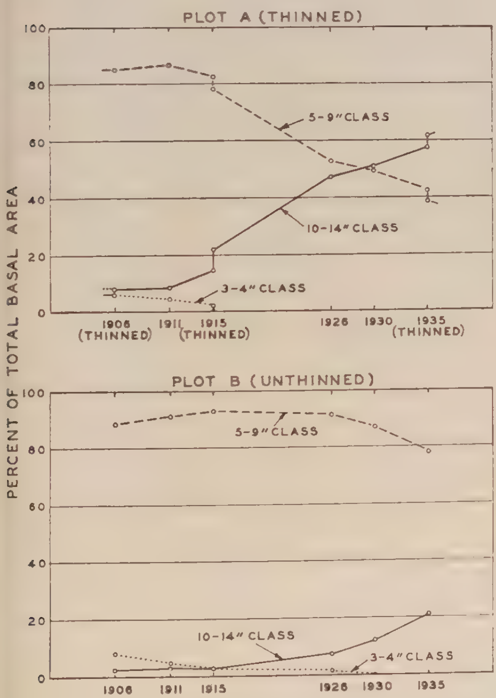

Fig. 2.—Changes in diameter class distribution at each remeasurement period based on per cent of total basal area.

Though the preponderance of basal area was in the 5-9" class on both plots in 1906, by 1926 there were about equal amounts in both the 5-9" and the 10-14" classes on the treated plot. However, throughout the entire period, on the unthinned plot, the greatest portion of basal area was in the 5-9" class, with only a small amount in the 10-14" class. This graph also indicates, as noted in the decrease in basal area in the 5-9" class after treatment, that the thinning was, in effect, from below.

Volume.—Comparative growth figures for the two plots, in which the average periodic annual increment of the red spruce trees on the plot is depicted, may be found in Table 1.

One distinct advantage in thinning is shown in the average annual volume increase for the entire period of 29 years, which was much greater on the thinned plot than on the unthinned plot. The average increment on the treated area was 61.8 cubic feet per acre per year, while on the check plot this average amounted to a minus 6.1 cubic feet—an

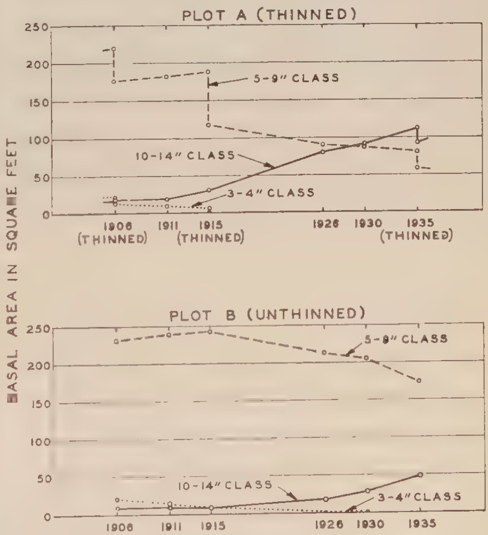

Fig. 3.—Basal area of red spruce present at each remeasurement by inch diameter groups in square feet per acre.

increase of about 68 cubic feet per acre per year brought about by thinning.

The minimum diameter of merchantable material, from the standpoint of pulpwood, may be placed at 4.6 inches breast high. For purposes of discussion, all the trees falling in a class below this limit were placed in one group, and those of merchantable size in another. These volume data are summarized in Table 2.

Although a decrease in total live volume occurred on both plots between 1906 and 1933, further analysis of the data indicates that thinning resulted in a net volume increase. The decrease in total live volume amounted to 1,250 cubic feet per acre for the treated plot, and 178 cubic feet for the check plot. However, taking into account the 3,041 cubic feet removed in thinning, the total net volume increase on Plot A amounted to 1,969 cubic feet more than on Plot B. This increase in net volume as shown by the data, was due to increased growth occasioned by thinning, and a decrease in mortality. The latter feature will be discussed later in this report.

A further summary of volume changes is graphically presented in Figure 4.

This graph shows the total live volume in cubic feet, with the cumulative volume removed in the thinnings. About 1,970 cubic feet more gross volume per acre accrued on the thinned plot, during the 29-year interval, than on the control plot (exclusive of mortality).

Analysis of the data indicates that in addition to the benefits mentioned before, thinning can be made to pay for itself, and further yield a cash income to the owner. There were 33.8 cords of material removed in the three thinnings, averaging 11.3 cords per acre for each operation. Assuming a stumpage value of $2.50 per cord, this amounts to a minimum return to the owner of $28.25 per acre for each thinning.

The data show that more trees died on the control plot than the thinned plot. During the time these plots have been established, 620 trees per acre have died on the check plot, and only 150 trees in the thinned plot. This remarkable difference in mortality is another indication of the benefits that may be derived from thinnings. (See Table 3).

The greater volume loss on the untreated plot indicates significant comparisons that can be made. The average annual volume lost through mortality was more than four times greater on the control plot than on the treated plot, amounting to 49.2 and 11.2 cubic feet per acre respectively. As the average annual increment (Table 1) for the unthinned plot was a minus 6.1 cubic feet per acre, the data indicate a deficit in the net annual increment of 55.3 cubic feet. On the other hand, an increase of 50.6 cubic feet per acre accrued on the thinned plot, over that lost through mortality.

The following discussion of net and

TABLE 1

PERIODIC ANNUAL INCREMENT OF ALL RED SPRUCE TREES 2.6 INCHES OR MORE IN BREAST HEIGHT DIAMETER, IN CUBIC FEET PER ACRE, 1906-1935

Plot	1906-11	1911-15	1915-26	1926-30	1930-35
A	34.0	101.0	55.6	51.5	79.6
B	21.8	26.2	—32.0	20.2	—[1]

[1]This plot was subdivided in 1935 owing to windfall occurring on one side of the plot as a result of an adjacent cutting. The increment figures are variable; the average annual increment for the plot as a whole (1930-35) was a minus 24.2 cubic feet; for the section free of windthrow (sub-plot 1), a plus 62.8 cubic feet; and for the portion subject to windthrow (sub-plot 2), a minus 130.0 cubic feet.

gross volume growth, as influenced by volume loss through mortality, is based on the data presented in Table 4.

A comparison made between gross volume growth of the thinned and unthinned plot indicates that, for every remeasurement period between 1906 and 1935, the gross volume growth was greater on the former. During the first period this difference was not great, signifying that the effect of thinning was not evidenced in any great degree for the first five years; but, during the 1911-15 period, the thinned area produced an excess of 156 cubic feet per acre over that of the control. However, during the ten years following the second thinning in 1915, the gross volume growth on the thinned plot was nearly twice as great as on the unthinned plot. The greater difference was due, in

TABLE 2

VOLUME OF RED SPRUCE TREES ON PLOTS A AND B IN CUBIC FEET PER ACRE AT EACH REMEASUREMENT PERIOD

Year			Plot A Diameter class 3-4"	5"+	Total	Plot B Diameter class 3-4"	5"+	Total
1906	Before cutting	Vol.	305	4,362	4,667	301	4,362	4,663
		Per cent	6.5	93.5	100.0	6.5	93.5	100.0
	After cutting	Vol.	194	3,607	3,801		None cut	
		Per cent	5.1	94.9	100.0			
1911		Vol.	95	3,876	3,971	197	4,575	4,772
		Per cent	2.4	97.6	100.0	4.1	95.9	100.0
1915	Before cutting	Vol.	80	4,296	4,376	124	4,753	4,877
		Per cent	1.8	98.2	100.0	2.5	97.5	100.0
	After cutting	Vol.	—	3,060	3,060		None cut	
		Per cent	—	100.0	100.0			
1926		Vol.	—	3,672	3,672	7	4,518	4,525
		Per cent	—	100.0	100.0	0.2	99.8	100.0
1930		Vol.	—	3,878	3,878	—	4,606	4,606
		Per cent	—	100.0	100.0	—	100.0	100.0
1935	Before cutting	Vol.	—	4,276	4,276	—	4,485	4,485
		Per cent	—	100.0	100.0	—	100.0	100.0
	After cutting	Vol.	—	3,417	3,417		None cut	
		Per cent	—	100.0	100.0			

TABLE 3

NUMBER AND VOLUME OF RED SPRUCE TREES DYING BETWEEN REMEASUREMENTS BY SIZE Classes (Per Acre)

Plot		D.b.h. class	1906-1911	1911-1915	1915-1926	1926-1930	1930-1935	Total
A	No.	3-4"	95	10	—	—	—	105
		5+"	5	5	30	5	—	45
		Total	100	15	30	5	—	150
	Vol.	3-4"	92.9	10.0	—	—	—	102.9
		5+"	19.5	9.5	150.5	41.5	—	221.0
		Total	112.4	19.5	150.5	41.5	—	323.9
B	No.	3-4"	95	65	95	5	—[1]	260
		5+"	25	55	180	30	70	360
		Total	120	120	275	35	70	620
	Vol.	3-4"	87.3	50.4	117.0	7.0	—	261.7
		5+"	55.5	112.5	653.5	113.0	231.4	1165.9
		Total	142.8	162.9	770.5	120.0	231.4	1427.6

[1] Based on portion of the plot not influenced by the adjacent 1915 cutting.

a large measure, to the heavy mortality occurring on the check plot during this interval.

After 1926 the gross volume growth was not as great as during the previous period immediately following the 1915 thinning. This seems to indicate that another light thinning should have been made in 1926. Analysis of the annual increment data before and after 1926 (Table 1) shows that a decrease in net increment occurred after 1926, and this value did not approach that of the 1911-1915 period until 1935. It is reasonable to expect that under ordinary conditions the owner of such a stand could profitably have made another thinning in 1926.

Spruce is normally a long-lived tree, and under normal conditions in an uneven-aged stand, does not begin to fall off in mean annual increment until about 80 years of age.[4] However, in old-field spruce stands of the density depicted in the control plot, stagnation begins to occur at a relatively early age. Light thinnings at intervals of about 10 years should be initiated in stands of this type before stagnation begins.

Under certain conditions where intensive management was being practiced on a stand such as this, a major portion of the material listed under "loss through death" might be utilized. In this case the gross yields per acre over a long interval of time, in stands that had been thinned, would far exceed that on untreated areas.

Another important result of thinning old-field spruce stands is evidenced in the change in form that may result. The work of Bornebusch[5] in red spruce plantations is indicative of the trend of the investigations that have been made along this line. It might be desirable to investigate this relationship in more detail, and determine the degree of thinning most productive of better form.

Reproduction.—In addition to producing a greater total net volume per acre, thinnings result in conditions which are conducive to the establishment of abundant reproduction. The predominate influence of thinning in this respect is in the creation of openings in the forest canopy which allow more light to filter through to the forest floor, thereby stim-

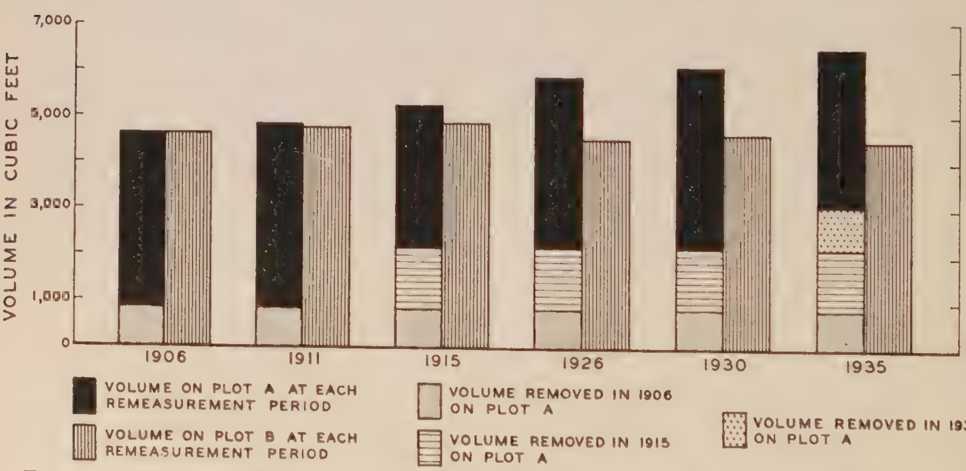

FIGURE 4

Fig. 4.—Volume in cubic feet per acre on Plot A and B at each remeasurement with the accumulative volume removed by the thinnings in 1906, 1915, and 1936.

[4]Meyer, Walter H. Yields of second-growth spruce and fir in the Northeast. U. S. Dept. Agr. Tech. Bull. No. 142. 1929.

[5]Bornebusch, C. H. Thinning experiments in red spruce forests. Det Forstlige Forsoegsvaesen I Danmark 13(2): 117-210. 1933. (Division of Silvics Translation No. 193).

ulating the growth of the existing coniferous seedlings. This influence is illustrated by the 1935 reproduction tally summarized in Table 5.

The two thinnings on Plot A have resulted in a much better stand of coniferous reproduction than on the check plot. Though only a relatively small portion of the large number of coniferous seedlings below 0.5 feet in height usually survive, conifers in this height class were much more numerous on the thinned plot. The presence of abundant reproduction in the larger height classes is especially desirable from the standpoint of survival after logging. In contrast to the total absence of any coniferous reproduction above 0.5 feet in height on the control plot in 1935, the thinned plot supported more than 2,800 individuals per acre between 0.5 and 2.0 feet in height. Besides being more capable of pushing up through slash, reproduction of this size can compete more adequately with invading raspberry and blackberry bushes that often follow the clear cutting of old-field spruce stands.[6]

TABLE 4

THE NET GROWTH, LOSS THROUGH DEATH, GROSS VOLUME, AND THE PERIODIC ANNUAL PRODUCTION DURING SUCCESSIVE PERIODS

Period		Plot A (Thinned)		Plot B (Unthinned)	
		Cubic feet per acre			
		Period	Annual	Period	Annual
1906-1911	Net growth	170	34.0	109	21.8
	Loss through death	112	22.4	143	28.6
	Gross growth	282	56.4	252	50.4
1911-1915	Net growth	405	101.2	106	26.5
	Loss through death	20	5.0	163	40.8
	Gross growth	425	106.2	269	67.3
1915-1926	Net growth	612	55.6	—352	—32.0
	Loss through death	150	13.6	770	70.0
	Gross growth	762	69.2	418	38.0
1926-1930	Net growth	206	51.5	81	20.2
	Loss through death	42	10.5	120	30.0
	Gross growth	248	62.0	201	50.2

TABLE 5

SUMMARY OF REPRODUCTION IN 1935 (PER ACRE BASIS)

		Height in feet			
		0-0.5′	0.6′-1.0′	1.1′-2.0′	Total
Plot A (Thinned)	Conifers	264,100	2,680	105	266,885
	Hardwoods	370	53	—	423
	Total	264,470	2,733	105	267,308
Plot B[1] (Unthinned)	Conifers	75,907	—	—	75,907
	Hardwoods	544	—	—	544
	Total	76,451	—	—	76,451

[1]Undisturbed portion of check plot.

[6]Westveld, M. Reproduction on pulpwood lands in the Northeast. U. S. Dept. Agri. Tech. Bull. No. 223. 1931.

EXPERIMENTAL WORK WITH THE INTRODUCTION OF CHEMICALS INTO THE SAP STREAM OF TREES FOR THE CONTROL OF INSECTS

By F. C. CRAIGHEAD and R. A. ST. GEORGE

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The introduction of chemicals into the sapstream of living plants for the control of insects and diseases and also for the preservation of the wood has been the object of experimentation for more than 100 years. It has been found that this principle is thoroughly sound within certain limitations. It is likewise practical for purposes to which it can be adapted, such as the treating of small timbers in the round and for the control of bark beetles. Two papers follow, one by F. C. Craighead and R. A. St. George and another by W. D. Bedard. The former paper discusses the more general aspects of the problem of introducing chemicals into trees while the latter describes the application of the method for the control of the mountain pine beetle.

THE treatment of trees attacked by parasitic organisms by the introduction of chemicals into the sap stream of the living plant has intrigued workers for over 100 years. Considerable serious experimental work has been done, many methods for introducing the chemicals into the sap stream have been patented, and there is a large literature on the subject. Unfortunately, charlatans and quack tree doctors have not been slow to take advantage of such methods, and it should be stated immediately that, to our knowledge, no practical method of killing the parasite without harming the tree has been developed.

Past experimental work in this field has been directed toward a great variety of objectives, such as the preservation of wood from decay; the coloring of the wood for special uses; the treatment of physiological diseases resulting from the deficiency of certain chemicals; the control of fungous diseases, such as chestnut blight, already infecting the trees, and the control of insects attacking the trees, including the sucking, leaf-feeding, and bark-boring types. In practically no cases have fully successful results been obtained. Nevertheless, the possibility of developing a satisfactory technique capable of practical application does not seem to have been exhausted, and from the chemical and physiological standpoints the principles involved would appear to be sound.

For 10 years the Bureau of Entomology and Plant Quarantine has been experimenting in this field for the control of tree-killing insects, chiefly the bark beetles. The more technical phases of the work have been conducted at Asheville, N. C., while large-scale field tests have been made in Virginia, California, Montana, and Idaho, and recently on elm in New Jersey. The results of this work have not been completely successful under all conditions tested, but they have been very encouraging and for some purpose this form of treatment has proved more economical and practical than methods now in use.

Historical Résumé

The following brief review[1] of the beginning and development of the chemical treatment of trees (8) will serve to call attention to the wide interest in this field,

[1]The early historical summary presented here is largely adapted from Friedrich Moll's paper "Die Imprägnierung des Holzes."

which in more recent years has come to have practical application in various ways. The main thought behind the initial investigations appears to have been the preservation of wood. Magnol in 1709 (cited by Sachs) (14) was the first to discover the rise of sap in plants. In this work colored solutions were employed to trace the course of the sap stream. Next in importance is the contribution of the English physician Hales (4), who in 1730 recommended to the British Admiralty the boring of holes into the stems of trees and filling them with wood tar. In 1733 De la Baisse presented to the Academy at Bordeaux a paper on the subject of the rise of sap and the ascent of colored liquids in plants. In 1754 Bonnet (1) published a paper dealing with the function of the leaves in connection with the ascent of sap. In 1755 Buffon (2) discussed this same question in his "Natural History". In 1804 Saussure (15) made one of the outstanding contributions of his time by introducing toxic solutions, as well as stains, into the sap stream of trees. Among those used was copper sulphate, which played an important part in the well-known work of his successor Boucherie. Saussure was followed in 1806 by Cotta (3), who applied various salt solutions to growing trees and made them rise in the sap stream. During the next few years, tree injection made noted advances through the efforts of Boucherie, who succeeded in putting the ideas of his predecessors into practical use by working out a method for the impregnation of wood which, with some modifications, was used in Europe (France, Germany, and Austria) for many years, and in recognition of which the French Academy of Science significantly honored him.

Boucherie's first attempts in the field of tree injection relate to boring a hole in the trunk at the base of the tree and, by the aid of a keyhole saw, severing the wood to within an inch of the bark on each side. A solution contained in a barrel was then introduced through a tube by gravity to the bore hole, whence it was rapidly absorbed by the severed tissues in the tree.

Further work in this direction was done in 1841 by Lipowitz (5), who verified Boucherie's findings.

Later Boucherie changed his method of injection because he found it difficult in the case of large trees to make the cut with the keyhole saw. His next step related to the felling of the trees. This soon proved unsatisfactory, however, because it was difficult to handle the larger ones readily while placing the lower end of the severed trunk into a container holding the solution. Because of this he turned his attention again to the standing tree.

Working with the standing tree, Boucherie made his next injections by using the saw externally. He made a cut which completely encircled the trunk and, by means of a tar-soaked cloth, bandaged the kerf so that it retained the introduced solution until it was absorbed. He was dissatisfied, however, with the results obtained, since distribution was confined mainly to the outer rings of sapwood and, further, much of the solution was lost, as it was taken up into the crown and roots—parts of the tree in which he was not interested, as he was seeking to preserve only the main stem, which could be utilized for ties and for lumber. His objective was to treat the entire cross section, if possible.

Following this he took up again his former idea of felling the trees, but modified his procedure by cutting off all but one limb of the top. In this way he found that it was more nearly possible to accomplish his purpose. To impregnate trees treated in this way, he tied a waterproof bag filled with a solution of

copper sulphate over the lower end of the log.

In subsequent tests he completely topped the trees and replaced the bag with a box to serve as a container. With the latter, however, it was necessary to raise the trunk of the tree higher than was the case with the former receptacle. Finally, with further developments, the box was replaced with a board which served as a cap across the end of the cut surface of the trunk. By placing a rubber ring or other similar material around the rim of the section, sufficient space was left within the ring between the inner surface of the board and the end of the log to allow the solution to enter the severed tissues and be distributed throughout the stem.

Boucherie's oldest patents were taken out in 1838, but his principal one was obtained in 1841. The latter covers particularly the impregnation of railroad ties. These tests served as a basis of much of the later work in tree injection. Modifications of this method are numerous, and hundreds of patents have been taken out on methods of injecting trees for various purposes. Today there are some companies which still use a modification of Boucherie's methods to impregnate poles. The way in which this is done is to arrange a series of freshly felled poles in a row, cap the ends, and then introduce a preservative, which comes from a common reservoir that is placed high up on a platform so as to increase the hydrostatic pressure and insure a more thorough impregnation of the wood. In most instances, however, the Boucherie method of impregnation has been replaced by hot and cold dip treatments or by the more modern pressure processes. Also, the corrosive nature of copper sulphate has resulted in its abandonment as a commercial preservative.

In addition to the preservation of wood, the work has extended along other lines as well. Methods have been devised for the coloring of wood, for supplying diseased trees with nutrients and chemicals which they lack, and for introducing toxic substances to protect the wood from the attack of various insects and wood-rotting fungi. The contributions in these fields are too numerous to permit the mention of each of them in this paper, but reference will be made to a few of the most important.

Probably the majority of the papers on tree injection published during recent years relate to the treatment of fruit trees to supply deficient elements. Other contributions have been made in relation to the treatment of trees attacked by fungus diseases and by insects.

As early as 1903 Mokrzecki (7) in Russia, reported that fruit trees suffering from chlorosis could be successfully treated by injecting solutions of iron salts through bore holes made in the diseased trunks. Since then considerable work has been done in this field.

A notable contribution in relation to the possibilities of controlling fungus diseases is that of Rumbold (10, 11, 12, 13) in Pennsylvania, during the period 1912-14, while she was working with the chestnut blight disease (*Endothia parasitica* (Murr.) A. & A.). This work demonstrated that injections of dilute solutions of lithium carbonate and lithium hydroxide checked the blight temporarily and caused the infected trees to form considerable callous growth which resulted in cutting off the diseased tissue. As the effect of the chemical was gradually eliminated, however, the trees once more became susceptible to the disease. The work, nevertheless, indicated the possibility of finding a cure for tree diseases by this method. Further, in 1927 Metzger (6), in Germany, mentions the work of Koenig of Hamburg, who treated a series of diseased elms by the bore-hole method of injection. It is stated that the trees

responded well to a treatment with a certain fluid. Later several cities in Germany were ordered to test this method.

So far as is known, all attempts to kill insects attacking living trees by means of chemicals introduced into the sap stream and at the same time to save the host have met with little success. Work has been directed at the control of such pests as aphids, various scales, the bronze birch borer, and the locust borer.

Of particular interest is the work of Dr. Otto von Müller (9) in Germany, who tested the effect of many materials on insects and on trees and other plants by introducing chemicals in bore holes made in the stems. Most of his efforts met with little success. He did succeed in controlling aphids under laboratory conditions by the use of a 5 per cent solution of pyridine, but his attempts to repeat this in the field were unsuccessful. In most instances dosages strong enough to kill the insects also injured or killed the host plant.

Another application of the tree-injection principle, and one that has been used most often in recent years, is the poisoning of undesirable tree species for clearing land and for thinning in silvicultural operations. For this work the hack-girdle method has been used principally, and in the severed rings of wood solutions of arsenic, copper sulphate, and other poisons have been applied to the severed tissues in the girdle. Considerable experimental work in this direction has been done by the Forest Service of the United States Department of Agriculture.

Objectives in the Experimental Work

The control of insects attacking forest and shade trees has always presented practical difficulties because of the large size of individual trees and the consequent expensive equipment or large amounts of manual labor required in spraying, felling, and barking the trees or in applying wood preservatives. Obviously the introduction of chemicals into the sap stream of the standing tree will be far more economical if a practical technique can be developed. In our work the chief aim has been to develop cheaper, more efficient methods of controlling bark beetle infestations, of preventing insect attacks on certain types of forest products, and of controlling shade-tree pests.

Control of Bark Beetles.—For the control of bark beetles in forest trees federal agencies spend several hundred thousand dollars annually. The cost of treatment ranges from about $1 to $20 per tree, depending on its size and accessibility and the particular method employed. The bark beetles that kill these trees make their attack along the stem in great numbers, boring through the bark and constructing between the bark and wood the tunnels in which the broods develop. The usual practices in control are to fell the tree and burn it or to remove or burn the bark. In all cases the tree dies—often within a week or so after it has been attacked it is beyond recovery—and consequently we are concerned only with killing the insects to prevent their spread to other green trees and not in saving the particular tree treated. Trees killed by bark beetles decay rapidly; therefore a chemical that will kill the bark beetles and, in addition, will preserve the wood and make it possible to utilize the tree some years after, when logging operations go through the area, would be doubly valuable.

For the purpose of bark beetle control, where local labor, often of a mediocre quality, is utilized, very simple methods must be used. From the chemical standpoint a salt is needed that is readily soluble in water, that is nonpoisonous in ordinary quantities to man or the higher animals, and that is effective in relatively small amounts and can therefore be easily transported. Such chemicals as

sodium arsenite, sodium arsenate, and bichloride of mercury have given good results from the standpoints of both insect control and wood preservation, but they leave materials in the wood that are dangerous to human and animal life. Zinc chloride and copper sulphate, or blue vitriol, are satisfactory, although the latter has a corrosive effect on metal fasteners such as nails.

In treating coniferous trees infested by bark beetles the most serious difficulty encountered is the stoppage of conduction, and consequent interference with the movement of the chemical solution through the tree, caused by the development of fungi —the so-called blue stains—which the bark beetles introduce at the time they attack the tree. Blue stain development varies greatly, depending on the species of bark beetle, the host tree, and temperature and moisture conditions within the tree. For example, with the southern pine beetle in shortleaf pine in the South, these blue stains will permeate the outer layers of sapwood within 5 to 7 days after attack, and it is rarely if ever possible to obtain effective distribution of the chemical or destruction of the bark beetles unless the trees are treated within this time. This limits the usefulness of this method in the Southeast—in fact, makes it really impractical for forest work. With the mountain pine beetle in white pine, in Idaho and Montana, where development of blue stain is much slower, successful control of the broods can be obtained for 60 or even up to 90 days after the trees have been attacked.

Several small control operations have been conducted against the mountain pine beetle in white pine on the Coeur d'Alene National Forest in Idaho and on the Kaniksu National Forest in Washington by J. C. Evenden and his staff at the Coeur d'Alene laboratory. The results, after preliminary difficulties were overcome, have been wholly successful and the methods of treatment are much less expensive than those usually employed in that region.[2] The early partial failures in this work were due to the fact that too long an interval was allowed to elapse between attack by the beetles and the application of the chemical treatment, thus permitting the development of blue stains in the sapwood.

Prevention of Insect Attack in Forest Products.—Another objective is the treatment of crude forest products such as poles, posts, and timbers in contact with the ground, and material to be used for rustic work such as furniture, cabins, and bridges, to prevent insect attack and also the shedding of the bark. Untreated poles and posts of many woods placed in the ground are quickly riddled by termites and borers. There are comparatively few termite-resistant woods. Materials used in rustic work such as cabins, furniture, etc., are attacked by bark beetles and the larger borers, and by wood-boring beetles and powder-post insects that loosen the bark and riddle the wood.

For this class of products simple methods are again necessary, and cheapness and thorough impregnation of the sapwood are essential, though more costly methods may be used than in the case of bark beetle control, as the value of the wood is much higher. The chemicals to be used should be both good insecticides and good wood preservatives.

Posts, rustic work, etc., treated with a number of chemicals have now been subjected to service tests for 6 years. These tests indicate that after 6 years in the ground the posts and poles are still in a perfect state of preservation, showing no insect injury or decay. A rustic-work

[2]Described in contemporary paper by Bedard, "Control of the Mountain Pine Beetle by Means of Chemicals." This Journal, pp. 35-40.

cabin with the logs treated by this method was constructed 2 years ago. Already the untreated check logs are badly damaged by insects and the bark is falling away, while the sticks treated with adequate chemicals show no insect damage, and the bark has remained tight. With such chemicals as copper sulphate and zinc chloride, the standard commercial concentration of ½ pound per cubic foot of wood is readily obtained. Other chemicals that have given satisfactory service tests will be mentioned later. Many of these, however, are either dangerous or impractical for various reasons. At the present time the most suitable chemical for these purposes seems to be zinc chloride.

It should be clearly understood that this treatment for forest products does not take the place of present-day commercial treatments for wood preservation. It is particularly useful for the farmer for treating poles, fence posts, and logs used in the round, for the manufacturer of rustic furniture, or for an individual who, in erecting cabins or other structures, wants to use a small amount of material on which the bark is to be retained.

Control of Shade-tree Insects.—Another objective is the control of insects attacking trees of high aesthetic value, such as trees along streets, in parks, or in recreational areas. Three types of insects are concerned—bark borers, sucking insects, and leaf-feeding insects. As the value of an individual tree is very high, cost is not such a consideration and elaborate technique can be utilized. The chemical, however, must not injure the tree. Here there is a wide field for the biological chemist in developing differential materials that will be toxic to the parasite and harmless to the tree. Working in this field the quack tree doctor often reaps a harvest. Almost anyone is willing to spend 25 cents to several dollars to save a fine shade tree. The usual method employed is to play on the tree owner's credulity, bore a hole in the side of the tree, introduce a pellet, plug the hole, and disappear from the community. The work of the Department of Agriculture with shade trees has not progressed very far. It has developed a technique that will introduce chemicals into the sap stream without unduly injuring the tree, but much work lies ahead on the chemical side of the problem. Thus far no chemicals have been tested that have a sufficiently wide differential in their toxicity to be harmless to the plant and yet destroy the attacking insects.

Methods and Technique

In the first experimental work some 10 years ago attempts were made to introduce chemicals into the sap stream of trees by boring holes into the trunk of the tree at several places around the stem and connecting these with a reservoir containing the chemical solution. Although this method has been recommended in many publications that have appeared from time to time, particularly for use in the treatment of physiological diseases, very little experimental work was needed to demonstrate that it is ineffective when the entire stem of the tree, the branches, and the foliage are to be treated. Inasmuch as there is very little lateral movement of the sap stream within the stem of a tree, a chemical introduced at one point will go up the stem in only a narrow strip and will affect only those limbs directly in connection with the point of inoculation. It soon became evident that it was necessary to introduce the materials around the entire circumference of the tree in order to get adequate and uniform distribution to all parts of the stem and crown.

With this essential requirement determined, a great number of methods have been utilized, among which the following have proved most simple and satisfactory.

All methods require that the tree be green and that the crown be left intact during treatment. The simplest method to be used with small trees consists in cutting the tree off at the base and setting it in a pail of solution while the top is lodged against an adjacent tree or otherwise supported. Another method involves the removal of the bark from around the base of the tree, after which a notch is sawn around the tree cutting through several annual layers of wood. A wide rubber band is then stretched over this notch and fastened with staples, after which the solution is fed into the notch from a container, suspended above.

A number of modifications of these methods have been tested with varying adaptability to certain trees and purposes. The concentration of the solution seems to be of little importance and only enough water to dissolve the chemical is necessary. For example, a pound of copper sulphate will dissolve in about a half gallon of water. With some salts as little as a pint of water can be used. Recent work is directed at testing the possibility of using the salt dry by merely removing the bark and bandaging the dry salt around the surface of the wood.

Stains have been utilized in many of our early tests so that the movement of the chemical could be followed through the wood. Light green, S.F., acid fuchsin, gentian violet, and many other stains have been tried and, except for special purposes, have been finally abandoned and the distribution of the injected liquid throughout the tree determined by chemical analyses. These stains do not always move at the same rate as the chemicals. They have some use, however, as general indicators of movement.

Species Susceptible to Treatment.—The experimental work has been based on tests with a limited number of tree species, principally pine, spruce, fir, oak, hickory, and yellow poplar. It is quite likely that many other species can be treated effectively by these methods.

Time of Year for Treatment.—Green, healthy conifers can be injected with chemical solutions successfully at any time of the year except during freezing weather. Absorption of the chemicals is, however, more rapid during the growing seasons. Hardwoods will readily take up or absorb the chemical solution during the active growing seasons, commencing when the leaf buds begin to swell. After the leaves have fallen, treatment is possible but much slower and more difficult, and the results may not be so uniformly good.

Time Required for Treatment.—The time required to treat living trees varies to a considerable extent, depending on the physiological activity of the tree, particularly the rate of transpiration. On a bright sunny day a gallon or two of solution will be taken up in 1 to 3 hours, while in cloudy weather or on cool days 24 hours may be necessary. After all of the solution has been absorbed by the tree, the latter should be left for a period of 5 to 10 days to permit thorough distribution of the chemical throughout all parts of the sapwood.

Chemicals Tested for Insect Control

The chemicals listed below have all been tested in this work but will be discussed only briefly at this time, inasmuch as mention has already been made of the requisites of chemicals suitable for injection into the sap stream of trees for insect control and for the preservation of the wood. These chemicals are classified on the basis of results obtained from field tests designed to determine their toxicity to bark-infesting and wood-boring beetles.

Considering the chemicals as a group, those which were found to be most promising are the first nine listed in the effective column. Of these, all but four are soluble in water in nearly all proportions.

Effective for Insect Control

Zinc chloride	Potassium nitrate
Copper sulphate (blue vitriol)	Pyridine (crude)
Mercuric chloride (corrosive sublimate)	Ethylene dichloride
Zinc meta-arsenite	Formaldehyde
Sodium arsenate	Ethyl alcohol
Sodium arsenite	Methyl alcohol
Sodium fluoride	Butyl alcohol
Ammonium bifluoride	Potassium cyanide
Ammonium copper arsenite	Hydrocyanic acid
Sodium borate	Carbon disulphide
Sodium nitrate	Ether

Ineffective

Sodium sulphide	Picric acid
Potassium dichromate	Orthodichlorobenzene
Ethyl mercuric chloride	Gasoline
Ethyl mercuric sulphate	Kerosene
Chromic acid	Creosote

Sodium fluoride is soluble only up to 4 per cent at 15° C. (59° F.); sodium arsenate is soluble up to 26.7 per cent at 17° C. (64.6° F.); ammonium copper arsenite and zinc meta-arsenite are practically insoluble in water.

In reference to those chemicals listed as being ineffective, the organic compounds such as orthodichlorobenzene, gasoline, kerosene, and creosote were not suitable for tree injection since they are not readily introduced into the sap stream of the tree. Crude pyridine, listed among the effective chemicals, was absorbed very slowly.

The chemicals that act as fumigants, and the alcohols, although temporarily effective against broods of bark beetles in freshly attacked trees, are of no value as wood preservatives, since wood-infesting borers and fungi attack the tree or wood a short time after it has been treated.

Even the most promising chemicals have some disadvantages. As previously intimated, zinc chloride and copper sulphate (blue vitriol) are probably the most satisfactory, considering all requisites. Copper sulphate is the cheapest and, except for its corrosive action on metals, is nearly ideal. Zinc chloride is slightly corrosive when in contact with metals but not enough so to be of any consequence. Further, it has been noted on rare occasions that some of the cheaper grades of zinc chloride contain residual matter which forms a rather heavy precipitate when dissolved in water. Such precipitate has been known to form a thick slime-like mass in the kerf and to interfere somewhat with conduction. At such times the addition of acetic acid to the precipitate aids in clearing the solution.

Comparison of Old and Modern Methods

A perusal of the preceding discussion of our technique and a review of the literature of older work immediately raise the question as to present progress. As a matter of fact, Boucherie more than 50 years ago had overcome all the practical difficulties in the introduction of chemicals into the sap stream of trees. The writers have completely paralleled his work, not knowing the details of his method until 2 years ago. Present technique is an improvement over that of Boucherie only in that today superior materials are available. This work of Boucherie was lost sight of largely because of the development of modern machinery for treating wood with wood preservatives. Impregnation for the preservation of wood from decay was Boucherie's chief objective; he was not concerned with prevention of insect damage as such.

It would appear that the chief essentials in introducing chemicals into the sap stream of trees for insecticidal purposes

are (1) to see that the solution is in contact with practically all the conducting vessels of the tree, and (2) that the crown of the tree is left intact and actually functioning. This latter, of course, means that when the foliage is present, and active transpiration is under way, the chemicals are most readily absorbed. Apparently these features have been overlooked or not given sufficient attention by workers of the past 20 years.

In presenting this review of the experimental work of the Division of Forest Insect Investigations, Bureau of Entomology and Plant Quarantine, the writers by no means intend to imply that this method is a cure-all for all sorts of insect attack on forest and shade trees, or that it can in any way take the place of modern methods of commercial treatment of timbers for the purpose of wood preservation. It has, however, very distinct possibilities in bark beetle control, in the prevention of insect attack to crude forest products, particularly for the farmer in the case of poles and fence posts, or for the individual who wants to erect a rustic cabin; and future work may show that it has advantages in the control of shade-tree insects, although results up to the present have been distinctly negative.

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CONTROL OF THE MOUNTAIN PINE BEETLE BY MEANS OF CHEMICALS[1]

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THE injection of various materials into trees and smaller plants is by no means a new idea, and tests ve been made by various workers to termine the possibility of treating trees th toxic solutions to destroy detrimen- l organisms. This earlier work is re- ewed in a contemporary paper by aighead and St. George.[2] In the pres- t article are reviewed briefly only those idies which have been made of tree in- tion as a possible method of control- ıg the mountain pine beetle (*Dendroc- nus monticolae* Hopk.) in the northern ocky Mountain region.

The first work[3] of this nature was done 1926 in lodgepole pine (*Pinus con- rta* Loud.) on the Bitterroot National rest near Sula, Mont. During this and e four subsequent years approximately 0 infested trees of this species were ated on the Bitterroot Forest and on e Beaverhead National Forest near Wis- m, Mont. In 1930, following the work the lodgepole pine project, the loca- n of the experimental work was trans- rred to the Kaniksu National Forest in stern Washington, and all injections ıce that year have been made in western hite pine (*Pinus monticola* Doug.), on her the Kaniksu or the Coeur d'Alene tional Forest. In all, 600 lodgepole nes and 1,254 western white pines in- ted with the mountain pine beetle have en treated with various poisons and thods of injection. In the following ges, a description of injection technique and a list of poisons are given, followed by a brief discussion of the practical application of the method, suggested equipment, and organization of control crews.

Injection Technique

Numerous adaptations of auger holes and girdles have been tested in the search for a practical technique to get the poison solution into the conducting tissues of the tree. At the present time the "saw-kerf rubberized collar" method is the cheapest, most effective, and easiest to apply for western white pine.

In preparing the tree for this type of injection (Fig. 1) two parallel saw cuts approximately 3 inches apart are made completely around the tree, as nearly horizontal as possible, and just above the butt swell of the tree. The upper saw cut should penetrate the wood from ¼ to ½ inch so that the solution may readily enter the water-carrying vessels of the freshly cut xylem. The lower saw cut barely penetrates to the wood and is made to facilitate peeling the bark in a narrow strip where the collar is to be attached. After the band of bark has been removed, the wood surface is scraped slightly to permit a tight, leak-proof application of the collar, and a narrow strip of bark is removed perpendicular to and above the peeled band, where the two ends of the collar are joined and fastened to the tree. The collar material is then attached around the tree by means of tin strips and shingle nails, and the ends of

[1]This paper discusses large-scale practical tests of methods for the application of chemicals eloped experimentally at the Asheville, N. C., laboratory, as described in a contemporary paper.
[2]"Experimental work with the introduction of chemicals into the sap stream of trees for control of insects." This Journal pp. 26-34.
[3]Studies prior to 1931, all of which are unpublished, were made by J. C. Evenden, A. L. oson, H. J. Rust, R. A. St. George, and D. DeLeon.

the collar are overlapped and nailed to the tree in the same manner. The bottom of the collar should be just below and as near the upper saw cut as possible so that all of the solution will be utilized (Fig. 2). Following this operation the poison solution is poured into the collar, which stretches sufficiently to hold the desired amount.

When deep scars, checks, or punky convolutions into which the collar can not be fastened are encountered in the peeled band, it is sometimes necessary to apply two partial collars, one above the other. This can be done by fastening the ends of the main collar on each side of the scar and preparing the tree and attaching a short section of collar above the main collar, merely taking care that the entire circumference of the tree has been exposed to the poison.

Poisons

Of the following ten different poisons tested at various times during the course of these experiments, the first five were used in both western white pine and lodgepole pine and the last five only in western white pine: Sodium arsenite (Na_2HAsO_3), zinc chloride ($ZnCl_2$), sodium fluoride (NaF), copper sulphate ($CuSO_4 5H_2O$), potassium cyanide (KCN), sodium arsenate ($Na_3AsO_4.12H_2O$), sodium fluosilicate (Na_2SiF_6), mercuric chloride ($HgCl_2$), ammonium fluoride (NH_4F), and sodium thiocyanate ($NaCNS$). Of these poisons, the last two were but recently tested and their effectiveness will not be determined until the injected trees have been examined at a later date. Of the remaining eight compounds all but copper sulphate, sodium arsenate, and zinc chloride have been discarded because of their ineffectiveness or their extreme toxicity and consequent danger in use. At the present time, copper sulphate, as regards low cost, effectiveness, and ease in handling, appears to be the best poison used.

Blue Stains

In general it can be said that blue stains which limit the use of this method elsewhere do not prevent successful application in western white pine. Satisfactory control can be secured in trees up to 90 days after attack by the beetles. Even so the period of control is thus restricted to the late summer and fall.

Practicability of Tree Injection

In considering this chemical method of control, both its effectiveness and its practicability as compared with those of present control methods must be considered. During the seasons from 1933 to 1936, inclusive, tree-injection experiments were placed on a regular control-project basis.

Ordinary laborers of the type regularly employed for bark beetle control work were used to determine whether they were capable of injecting the trees properly, and to ascertain the man-day accomplishment for comparison with that by the methods now in use.

The average bark beetle mortality of over 90 per cent which was secured in the injected trees during these 4 years is sufficient evidence of the ability of ordinary laborers to inject trees successfully. Table 1 gives a comparison of the man-day production by tree injection during 4 years with that secured by peeling or decking and burning the infested logs. The figure from the Kootenai National Forest is an average based upon 3 years' control

Table 1

COMPARISON OF MAN-DAY ACCOMPLISHMENTS BY THE DECKING-BURNING AND INJECTION METHODS

National Forests	Method used and average number of trees treated per man-day: Decking and burning	Injection
Kootenai	2.00	- -
Coeur d'Alene	2.17	- -
Kaniksu and Coeur d'Alene		6.14

(Photo by H. J. Rust)

[Fi]g. 1. Tree prepared for application of collar. [Th]e bark has not yet been removed from the [pe]rpendicular strip for attachment of the ends of the collar.

(Photo by H. J. Rust)

Fig. 2. Completed collar made from knitted rubber sheeting.

work involving five projects, and the Coeur d'Alene figure is an average of eight projects during 5 years.

Table 1 shows that the average production secured by chemical treatment is approximately three times as great as that secured by the older method of bark beetle control. Although it is more difficult to compare the two methods on a cost basis, this greater production must necessarily be reflected in the cost of control. Obviously on a cost basis those expenditures under labor, subsistence, supervision, and transportation would be lowered because the same amount of treating labor would be in camp only one-third as long as required for the burning or peeling methods. Equipment costs would be approximately the same, when the extra expenditure required by tree injection for poison, banding material, tin strips, and nails is included. In order to permit a general comparison of the two methods on a cost basis, the activity costs for the spring-control work of 1933 on the Coeur d'Alene National Forest are compared in Table 2 with the approximate cost had this work been done by chemical treatment.

In explanation of the comparative costs shown in Table 2, each item will now be considered separately. The cost of "Supervision" is reduced two thirds because this figure includes salaries of camp managers and contributed time by permanent officers. Since the project would last only one third as long had treatment been by injection, only one third of the charge need be made against tree injection. A similar explanation applies for the reduced cost under "Cookhouse labor" and "Treating labor", except that cookhouse labor should not be reduced so much because of the extra spotters. The cost of "Spotting" remains the same even though the project extends only one third of the time, because it is necessary to increase the number of spotting crews in order to spot the same area in the shorter time. Costs under "Camps" and "Travel" would also remain the same in both types of control. It is more difficult to arrive at a satisfactory comparison of the costs for "Subsistence", "Transportation", and "Equipment". Under "Equipment" the rental for tentage, cookhouse equipment, etc., is somewhat less for injection because the project lasts only one third of the time. Likewise the cost of equipment for injection work is about three quarters of that used for peeling or burning. On the other hand, extra tentage is required to house the additional spotting crews. Under "Subsistence" the same difficulty arises. The amount of food consumed by spotting crews would remain the same,

TABLE 2

COMPARISON OF COSTS FOR BURNING AND TREE INJECTION PERIOD OF WORK: MAY 15 TO JUNE 29, 1933. NUMBER OF TREES TREATED: 4,552

Type of control	Decking and burning		Chemical treatment	
Item	Total expenditure	Cost per tree	Total expenditure	Cost per tree
Supervision	$ 2,324.34	$0.5106	$ 774.78	$0.1702
Spotting labor	7,688.69	1.6891	7,688.69	1.6891
Treating labor	8,240.26	1.8102	2,746.75	0.6034
Camps	1,964.32	0.4315	1,964.32	0.4315
Subsistence	3,743.59	0.8224	1,871.78	0.4112
Cookhouse labor	1,172.35	0.2575	586.17	0.1288
Travel	94.23	0.0207	94.23	0.0207
Transportation	2,272.30	0.4992	1,136.15	0.2496
Equipment	420.42	0.0924	315.30	0.0693
Chemical materials	0.00	0.0000	1,593.20	0.3500
Total	$27,920.50	$6.1336	$18 771.37	$4.1238

›ut that consumed by all other personnel vould be only one third as much during njection because they would be in camp ›nly one third of the time. The cost of 'Transportation" is decreased because ›ackers, truck drivers, stock, and trucks ıre used only one third of the time, but xtra men and tentage must be hauled. Jnder these circumstances it is felt that charge of three fourths of the expendiures under "Equipment", one half of hose under "Subsistence", and one half f those under "Transportation" is a conervative estimate of the cost reduction as result of chemical treatment. One facor which has not been considered is the aving accruing because of the fact that hemical treatment can be applied at a eason of the year when inclement weather oes not cause any lost time. In general, herefore, it may be said that the cost of hemical treatment would be approxiately two thirds of the cost for burning r peeling the infested logs. Economiclly, then, this method is decidedly suerior to present control methods in westrn white pine.

The question still remains as to which f the two methods is more efficient in estroying broods of the mountain pine eetle. Chemical injection of trees by resent methods is approximately from 95 99 per cent efficient. In the other ethod it is known that in certain cases ortions of unburned bark remain after e burning, and that when burning can longer be attempted in the woods beuse of fire hazard, peeling is not so ficient as either of the other two meths because the adult beetles are not estroyed. Furthermore, those trees in hich the mortality following chemical eatment is not high are mostly trees hich have been infested for some time, d these usually contain high percentages beneficial insects. An attempt has been ade to save these insects during control ork by not treating such trees. Chemical treatment, however, saves them automatically, because parasites and predators are not destroyed by the poison except in the few cases in which they have not completed their feeding.

It is also to be noted that this method eliminates the use of fire, which always becomes a menace near the end of spring control work when the forests become rather dry. Chemical treatment can also be applied early in the fall before the weather becomes bad, and thus the factor of inclement weather, usually encountered during spring and fall control work, is eliminated. The standing snags that remain after chemical treatment constitute one disadvantage of this control method which has not been eliminated, although some compensation may be had if it is possible to preserve these snags by the chemicals in such a state that they can be harvested several years later.

Crew Organization and Equipment

It has been found that, depending upon the type of infestation, either a 2-man or a 5-man treating crew is the most feasible one to use. In areas where the trees are scattered the 2-man crew works better, while the 5-man crew is better where trees are grouped. In the 5-man organization 4 men work in pairs as usual, while the fifth man mixes the poison and carries the water.

Each 2-man crew should be provided with the following equipment which, excepting pack frames and water cans, should be doubled for a 5-man crew:

Saw.—In preparing the tree it has been found that an ordinary docking saw with a fairly coarse set works best for cutting the saw kerf.

Chisel.—In this work a 2-inch wood chisel is very handy for peeling the bark and scraping the wood surface. It is advantageous to replace the wooden handle of the chisel with a short piece of

drill steel or metal pipe to give weight and extra length.

Collar Material.—The best collar material found to date is an inexpensive grade of knitted rubber sheeting. It is cheap, is a standard product which can be obtained at all times, and has sufficient elasticity to stretch with the weight of the solution. This material is purchased in bolts 1 yard in width, and by cutting the bolt in three pieces a roll of collar material 1 foot wide is secured.

Tin Strips.—The tin strips used to date are made from "1 x furnace tin" ½ inch wide and 2 feet long. Practically any sheet metal near 30 gauge in thickness will probably serve the purpose. It is also advisable to have the tin in 1-foot lengths in order to eliminate the need for cutting.

Nails.—Shingle nails have been used most successfully in fastening the tin. A large-headed nail similar to a bill poster's tack was tested in an attempt to eliminate the tin, but was not satisfactory.

Canvas Bag.—Two canvas bags 1 foot long and 2 inches square suspended from the belt facilitate transportation of the tin strips through the woods and keep them where they can be reached easily by the worker.

Pack Frame and Water Can.—A Nelson pack frame to which is attached a 5-gallon water can is desirable for transporting water in which the poison is to be dissolved.

Hammers.—Each man should be supplied with a hammer. A very cheap, light hammer is all that is necessary for this work.

Mixing Bucket.—Because of the necessity of mixing the poison in a noncorrosive container, a cheap wooden bucket was used during past projects and found satisfactory. For dosages of less than 1 pound of copper sulphate, a 1-gallon container is all that is necessary.

Knife.—A knife is necessary for cutting the collar material the proper length for each tree. In all probability all men employed on these projects will possess a jacknife, but if not the wood chisel will serve the purpose.

Poison.—The amount of poison carried by each 2-man crew depends upon the size of the dosages that are being injected. Past work has shown that a dosage of 8 ounces of copper sulphate dissolved in 3 quarts of water yields successful results in western white pine.

Conclusions

1. Western white pine trees infested with the mountain pine beetle can be injected with toxic solutions which, under certain conditions, will kill the bark beetle broods beneath the bark. The average mortality, when an effective poison and an approved method of injection are used, is over 90 per cent.

2. The saw-kerf rubberized-cloth collar method of injection has been found the most feasible method tested to date in western white pine.

3. Powdered copper sulphate ($CuSO_4$. $5H_2O$) is the most effective poison tested to date.

4. The distribution of the poison and resultant mortality are apparently governed by the development of the blue-stain fungus. Blue-stain development, in turn, is dependent upon the time elapsing between attack by the beetles and the injection of the poison, the density of the wood, and perhaps other factors such as the moisture content of the wood, the temperature, and the intensity of infection.

5. The successful introduction of chemicals into trees is limited to those in which the attack is not over 90 days old. This necessarily limits the time of injection to the late summer and early fall.

6. Injection of chemicals into trees is a more practicable means of controlling bark beetles in western white pine stands than any method used at the present time.

THE STRIP SURVEY ADAPTED TO PERMANENT SAMPLE PLOTS

By HENRY I. BALDWIN

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Various methods have been suggested for laying out permanent sample plots. All are time-consuming and relatively expensive. The advantage and disadvantage of the methods are discussed and a strip survey method is proposed which eliminates many of the disadvantages of the older methods.

SEVERAL printed instructions for laying out permanent sample plots have appeared (1, 5, 6, 11, 12 5, 16). There still seems to be little niformity as to method, and it is doubtul if the same technique is always the est for every kind of problem. Howver, standardization in some experimental echnique is highly desirable, and noteorthy progress has been made by the nternational Union of Forest Research rganizations (4, 10). The report of the ociety of American Foresters Committee n Sample Plot Procedure (9) has not et been issued to the writer's knowledge.

The usual practice in laying out permaent sample plots is to survey out squares r rectangles, using care to keep well ithin the borders of the same stand, and leave an adequate control belt or order around the edges and between lots. In cases where differences in stand r site make rectangular plots impraccal irregular polygons may be laid out, arefully excluding irregular parts of the tand (14). This involves much timeonsuming and accurate survey work, and, fter the areas of such plots have been omputed by latitudes and departures, ere is the further objection that subseuent office computations are complicated y uneven fractions of acres for reduction actors. Even rectangular plots require onsiderable accuracy in surveying, and abor in clearing and marking boundaries.

The criticism is often made of sample lot experiments that the results obtained n ¼-acre are not applicable to large areas, because the area studied is not sufficiently representative, i.e., the error of sampling is too great. The remedy would appear to be an increase in the number of plots. Anyone who has had to keep track of a few score sample plots year after year will realize that this isn't always feasible, at least it isn't economical except under very intensive conditions.

The increased areas covered by all kinds of stand improvement treatments during the past 4 years furnished an opportunity for installing permanent plots for determining the results of such treatments. Too much detail was not possible with the personnel at hand, usually 2 or 3 C.C.C. enrollees, picked up for temporary work for a day or two. Therefore in 1934 and 1935 there was worked out a simplified technique of permanent establishment of sample areas. This consisted in running compass lines through areas to be sampled exactly as in the strip method of timber estimating. First the area to be treated was gone over with the foreman of the improvement crew, and part of the area marked out as a control, to be left untouched. This was usually in the form of a strip running through the whole area, containing an average of all conditions. It need not have been straight or regular, but the boundaries were marked in some way. The method used is as follows:

A compass line is run along one boundary of the treated area, more or less parallel to the control area, which we shall assume to be located somewhere in

the midst of the treated area. Somewhere along this line a point is taken at random, from which a *permanent belt transect* (13) is run by compass at right angles off into the treated area. The beginning of this line is marked by a post or iron pin. The compassman leads off, dragging a 100-foot tape behind him. At the end of 100 feet he stops, and the rear chainman attaches a long piece of white string to the tape, to prolong the center line for later checking. The compassman then sets up his compass for the next shot and prepares to tally the individual tree record which the measurer calls out by number, species, diameter to nearest 1/10th in. (by diameter tape), crown class and other remarks. As he measures each tree he first makes a horizontal white crayon line on the bark at the place he measures. He is followed by two number painters (one of whom is also rear chainman) who paint or stamp (2, 3, 7, 8) horizontal white lines on the chalk lines, and above them, the tree numbers, which may have been chalked on by the measurer. Both lines and numbers face the tape. Trees are measured and numbered for a distance of 8¼ feet on each side of the stretched tape, doubtful trees being checked with a pole of that length laid at right angles to the tape. If more than one half the stump falls within the strip, the tree is included. This makes a strip one rod wide. When the first 100-foot strip has been painted, a new tally sheet or new notebook page is taken, and the compassman moves out a second hundred feet, and so on until the control area is reached, when a new page is again chosen, and labelled "control". Chainage notes are carried along with the tree records. When a sufficient distance has been traversed, an offset is made for about 200 feet and a line run back to the base line in the same way. Both ends of each strip are staked and marked Strip 1 NE end as the case may be. Usually an attempt is made to include about an equal chainage of control and treated areas.

One half mile of strip is equivalent to one acre in area, and is about as much as a crew can run in a day in fair-sized timber which is not very thick. However, this gives a very much better sampling of the area than a one-acre plot or several smaller plots, and at less cost in material and labor. The method is less adapted to yield studies, perhaps, than to simple determination of stocking, mortality, and growth. There is a large amount of border, and a relatively high percentage of the trees measured is on the edge of the "plot". There are several outstanding advantages of this method which may be summarized as follows:

1. A more representative sample of the area is obtained than with individual plots. This is especially true of large areas.

2. The data lend themselves to statistical treatment. Thus each 100-foot section of a strip, or each strip may be taken as a unit, and treated like replicate plots. This gives a chance to compare the observed differences in measurement in treated and control areas with the error of sampling.

3. Any extremely variable section of the "plot" may be excluded from the average. Areas on the border between control and treated areas may be omitted from numbering and measuring where it is considered they may be influenced by the adjacent areas. Thus the material included may be kept homogeneous without elaborate refinements of surveying.

4. Subsequent injuries or disturbances of the experiment are less serious. Logging operations frequently result in part or whole of a permanent sample plot being cut over "by mistake". The results of years are often lost, and the initial work of establishment is lost; with the strip method there is less likelihood of loss of the whole plot, and small sections which

have been disturbed may be eliminated without spoiling the results greatly.

5. Permanent strips are easier to lay out. It is not important that the line be absolutely straight, or that the survey close exactly. There are half as many corners to set, and if one or more are destroyed, they do not affect the validity of the results, provided the strip can be found.

6. The selection of the areas to be measured is more objective, more independent of personal judgment than in the selection of ordinary plots.

7. Permanent strips are easily located when another measurement is to be taken. They cannot be missed if one merely cruises through the area at right angles to them.

8. Numbered trees are found more readily than on large plots. Foresters who have remeasured plots without benefit of a map of individual trees, know how elusive a tree may be. When remeasuring a strip the numbers are in order, and are within about 8 feet from center line.

9. High numbers need not be used. Each strip may be started with No. 1 if there are many trees, and still there need be no confusion. This results in great economy of time in painting or stamping numbers.

10. There is economy of time and money in the original laying out of the sample areas (usually the major item of expense) on relocation, remeasurement and maintenance of the areas.

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CLEAR CUTTING OF YOUNG NORTHERN HARDWOODS STANDS

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In the northern hardwoods-hemlock forests of northwestern Pennsylvania the demands of pulp and chemical industries have led to the clear cutting of second-growth stands which are still immature. Studies show that this practice may bring about stand deterioration. In this forest type, management should aim toward periodic removal of products over a moderately long rotation.

BECAUSE of very close utilization by pulp and chemical industries, dating from about 1900, virgin or culled old-growth stands of birch-beech-maple-hemlock in northwestern Pennsylvania were removed by the clear cutting method. The nature of present second growth attests the success of this method in regenerating the old growth (4, 10). Though a large amount of defect may be present in the second growth (9), the composition is good on areas which were not burned. The stands are composed mainly of maple, black cherry, birch, and beech.

An example of the composition of an old-growth stand and of the ensuing second-growth reproduction is shown in Table 1. The area on which the data were obtained was culled about thirty years before the final cutting. At thirteen years of age, the second-growth reproduction consists of 4,250 stems per acre. Of these 55 per cent are seedlings, 43 per cent are seedling sprouts, and only 2 per cent are stump sprouts.

The second-growth data were obtained by tallying all trees on a strip 0.2 chain wide and 20 chains long, beginning at the edge of uncut timber. The young stand was essentially uniform in composition and density for the full length of this strip.

The cutting, although it was made under better than average conditions for reproduction, illustrates the factors responsible for the success attending regeneration of old-growth northern hardwoods by clear cutting. The culling which preceded the clear cutting by about thirty years aided in the establishment of advance reproduction. The fact has been verified by age counts of advance seedlings on the tract. At the time of cutting, most of the advance growth was cut back to the ground. Thereafter it sprouted to form a large share of the desirable element of the second-growth reproduction, represented chiefly by sugar maple seedling sprouts. The small proportion of stump sprouts is due to the fact that the stumps of the larger trees were past the age of vigorous sprouting. The black cherries in the second growth were all subsequent seedlings, for few trees of this species could exist in the understory beneath the shade of the former stand.

In one important respect the clear cutting of old growth was unsuccessful: it largely eliminated the very valuable conifers, hemlock and white pine, from the second growth. White pine was the first species to be cut on the northern Allegheny Plateau. Partly because of its high value and partly because of its characteristic occurrence in even-aged stands (7), the white pine was cut very clean, and sources of seed were early depleted. Hemlock has been handicapped in its competition with the second-growth hardwoods by

[1]Maintained by the U. S. Department of Agriculture at Philadelphia, Pa., in cooperation with the University of Pennsylvania.

slow growth, sensitiveness to fire, inability to sprout, and doubtless other factors.

Clear Cutting of Young Second Growth

Clear cutting, which served quite well in regenerating the old-growth hardwoods, has been the standard commercial practice in the northern hardwood type on the Allegheny Plateau. Now that the old growth is gone, the tendency is to clear cut the still immature second-growth forests of this region. Insufficient consideration has been given to the question of whether the differences between old-growth and young second-growth stands will not materially affect the nature of reproduction to be expected from clear cutting.

Cope (1) believes that repeated clear cutting on a 40-year rotation will probably maintain good stands of northern hardwoods. The area upon which his observations were made is located in Delaware County, N. Y. Clear cuttings were made in strips about 200 feet wide. Parts of the area have been cut for the second time. However, Cope does not mention any differences to be expected between the results of first and second clear cuttings. He cites Illick and Frontz (10) concerning the success of clear cutting northern hardwoods for acid wood; their conclusions apply to clear cuttings of old-growth stands.

Lutz (11) examined the reproduction resulting from clear cuttings of hardwood and hemlock-hardwood stands in southern New England. He concludes that retrogressive successions, often to inferior hardwoods, are to be expected.

Table 1

COMPARISON OF SECOND-GROWTH REPRODUCTION WITH ADJACENT CULLED OLD GROWTH SIMILAR TO THE STAND REMOVED

Species	Culled old growth	Second growth
	(Per cent of total number of stems)	
Sugar maple	37	64
Beech	57	14
Black cherry	3	5
Pin cherry	0	10
Red maple	1	2
Striped maple	0	2
Others	2	3

Sample Areas—Allegheny National Forest and Vicinity

Some tallies of third-growth reproduction were made on and near the Allegheny National Forest, in northwestern Pennsylvania, to determine the results of clear cutting young second-growth northern hardwoods. The composition of the third growth and of the stands removed is shown in Table 2.

Kane Experimental Forest Area.—All trees more than 0.5 inch in d.b.h. were tallied on 25 per cent of a 5-acre plot. A stand of 25- to 30-year-old second growth was clear cut from the area 13 years before. The second-growth composition data were obtained by tallying the surrounding uncut stand. The maximum distance to which the third growth was tallied was 6 chains from the second growth.

Sheffield Area.—This area of about 10 acres was traversed by a tally strip 0.2 chain wide and 10 chains long. All trees more than 0.5 inch d.b.h. were tallied. Stump tallies which had been made 3 years after the cutting furnished the data on second-growth composition. Stump sprouts were not abundant on either the Sheffield or Kane areas, perhaps because non-sprouting birches were numerous in the second growth.

Instanter Area.—The dominant seedlings or sprouts were tallied on 350 milacres, representing a sample of two small clear cuttings. The milacre stocking was 77 per cent. Stump tallies of second growth were made on 3½ acres.

Tiona Area.—A tallying strip 0.2 chain wide and 10 chains long was run from the edge of uncut timber into this area of about 30 acres. All reproduction was tallied by two-foot height classes. Three years before the reproduction tally was made, a 30-year-old stand consisting large-

ly of black cherry and sugar maple was removed. The exact composition of the second growth is not known, and for this reason the Tiona area does not appear in Table 2. A tally of the old-growth forest adjoining the cutting shows that the original stand was almost entirely of maple reproduction (about 80 per cent) and beech (about 20 per cent). Black cherry has built up in succeeding generations until now it constitutes 65 per cent of the third growth sampled, or 41 per cent of all trees over two feet in height.

The Tiona area illustrates the fact that the third growth is not invariably poor in composition, for sugar maple and black cherry combined make up 93 per cent of the young stand. However, it is a good example of other faults of early clear cutting, for 82 per cent of the trees over two feet in height and 43 per cent of all the trees are of stump sprout origin. Only two per cent of the trees are seedling sprouts. The scattered sprout clumps constitute poor stocking and inadequate site protection.

An inspection of Table 2 shows that definitely inferior reproduction has resulted from the clear cutting of young second-growth northern hardwoods. Intolerant weed species have come in abundantly. Black cherry, an intolerant but valuable hardwood, has increased somewhat over its proportion in the second growth, but of the other valuable species, sugar maple has decreased, and beech, black birch, and yellow birch have practically disappeared from the areas.

Some of the third-growth stands contain large numbers of stump sprouts, the shortcomings of which are commonly recognized. While the total number of stems per acre in the third-growth reproduction is high, the stocking is irregular.

The poor quality of the third-growth reproduction which followed these cuttings is not hard to explain. A great share of the desirable elements of second growth consisted of advance seedlings and of seedling sprouts from cut stubs of advance growth. When second-growth stands are cut at an early age, they are still without an understory of advance growth which might form the basis of a new

TABLE 2

COMPARISON OF THE COMPOSITION OF SECOND AND THIRD GROWTH ON THREE CLEAR-CUTTING AREAS

	Kane Experimental Forest		Sheffield area		Instanter area	
	Second growth 25-30 yr.	Third growth 13 yrs.	Second growth 45-50 yr.	Third growth 10 yrs.	Second growth 45-50 yr.	Third[1] growth 3 yrs.
	Species composition in per cent of total number of stems					
Undesirable species						
Pin cherry	T[2]	49	1	26	5	30
Red maple	13	11	0	0	15	7
Hop-hornbeam	0	0	5	13	0	0
Blue beech	0	0	T	13	0	0
Others	0	1	5	8	0	0
Desirable species						
Intolerant						
Black cherry	24	31	36	30	29	36
Intermediate and tolerant						
Sweet birch	21	0	4	1	3	1
Yellow birch	17	T	26	0	3	0
Beech	5	1	4	T	10	1
Sugar maple	16	6	11	8	34	22
Eastern hemlock	3	1	0	0	1	3
Others	1	0	8	1	0	0
No. stems per acre (All species)		4,207	....	3,450		....

[1]Dominant reproduction only.

[2]0.5 per cent or less.

stand. Restocking must be accomplished by stump sprouts and by the seedlings of early-seeding, intolerant species, most of which are forest weeds. On the areas studied, the tolerant and intermediate hardwoods failed to seed in satisfactorily. Seedling mortality (8) and age of seed bearing are probably the factors concerned. These factors require more investigation.

Ultimate Nature of the Third-Growth Stands

A final judgment of the merits of short-rotation clear cutting will hinge upon the future stocking and composition of the third-growth stands, which is a matter of some conjecture. Ultimate understocking is probable because the short-lived weed species sometimes exclusively occupy localized spots up to a size of one-half chain square in the third-growth reproduction. Desirable species may or may not seed in where openings are left by the death of "nurse" trees. Should the further invasion of more of the valuable trees occur, it will be only at the expense of years in the rotation. Cutting methods which do not depend upon the nurse crop succession are much more certain of producing desirable new stands in the shortest period of time.

Present knowledge of stand development indicates that black cherry will dominate in the composition of the future stands on the areas studied. While it now constitutes only one-third of the total number of trees, black cherry accounts for about half of the trees of long-lived species. Because of its vigorous growth, this species can be expected to form well over half of the future basal area of the third-growth stands sampled. Black cherry is considered a valuable species on the Allegheny Plateau, but very high proportions of it are not wholly desirable for several reasons:

(1) In a recent article Downs (2) has shown that black cherry in the northern hardwoods type is highly susceptible to glaze damage. He has recommended the encouragement of more of the resistant species, such as conifers and tolerant hardwoods.

(2) High proportions of black cherry are not wanted by chemical plants, for birch, beech, and sugar maple give better chemical yields.

(3) Black cherry produces large numbers of vigorous stump sprouts, particularly in short-rotation management. These sprouts readily dominate more valuable trees. They are of poor form and are subject to cracking off at the base (9). They also have certain characteristics which have been associated with sprout decay in more intensively-studied species.[2] These characteristics are high point of origin on the stump, early formation of heartwood, and slow decay of stump. In oaks, it has been found that where heartwood formation in the sprout precedes complete stump decay, there is great hazard of heartrot transmission from stump to sprout (12).

Limitations of Weeding in Third-Growth Reproduction

Weeding studies on the Kane Experimental Forest have demonstrated that many third-growth stands resulting from short-rotation clear cuttings do not justify investments in early stand improvement measures. In the first place the stocking is often too uneven to permit the selection of an adequate number of crop trees, and in the second place an excessive amount of work is frequently necessary to free desirable trees from the competition of large stump sprouts, and to keep them free. The obvious benefits of weeding in more workable stands are of course conceded.

[2]Memorandum from Dr. W. A. Campbell, Bureau of Plant Industry, U. S. Department of Agriculture.

Modifications of Cutting Method

A simple modification of early clear cutting is to reduce the size of cutting areas. However, reproduction tally strips have shown that the composition of third growth is apt to be as poor within the first five chains from uncut timber as it is farther away. This is an indication that desirable regeneration is not guaranteed by reasonable reduction in size of coppice areas. It should not be inferred that in older timber cutting of small groups, or in narrow strips such as Cope (1) suggests, may not succeed.

A second alternative to the ordinary coppice system is the lengthening of the rotation to permit the establishment of advance growth. One example of a clear cutting of 60-year-old second growth on the Little Arnot Creek, Allegheny National Forest, is indicative of the character of reproduction which may result. At the time of cutting in 1929 the stand of birch, beech, maple, and black cherry contained a small understory in which most of the seedlings were sugar maple. The composition of the stand removed and of the reproduction at ten years after cutting are given in Table 3.

Table 3

COMPARISON OF 60-YEAR-OLD SECOND GROWTH WITH ENSUING THIRD GROWTH 10 YEARS AFTER CLEAR CUTTING

	Second growth 60 yrs.	Third growth 10 yrs.
	(Per cent of total number)	
Undesirable species		
Red maple	7	16
Hop-hornbeam	3	4
Blue beech	T	0
Serviceberry	1	0
Fire cherry	0	3
Dogwood	0	2
Desirable species		
Intolerant		
Black cherry	10	16
Intermediate and tolerant		
Sugar maple	25	52
Beech	25	2
Yellow birch	9	T
Sweet birch	2	T
White ash	8	4
Eastern hemlock	3	0
Basswood	7	1

The proportion of sugar maple in the new stand is large, but the birches and beech have decreased markedly. There are 2,800 trees per acre; of these 22 per cent are seedling sprouts, 38 per cent are stump sprouts, and 40 per cent are seedlings. The proportion of seedling sprouts is higher than on the areas where the second growth was younger when clear cut.

But lengthening the rotation is not alone the answer to the problem on the Allegheny Plateau (10). For several reasons the longer rotation should be supplemented by intermediate cuttings:

(1) Most of the stands in this territory are now less than 40 years of age. If they are to be retained until they have reached a proper age for final cutting, intermediate products will be necessary to sustain the cordwood market.

(2) Through intermediate cuttings, otherwise wasted wood can be utilized and at the same time the value of the ultimate products can be improved. A diversification of products can be accomplished by the removal of cordwood in such a way as to benefit potential sawtimber (3).

(3) Reproduction cuttings can be expected to increase the rate of establishment of advance growth, so that good reproduction after the final cutting will be more certain.

Studies in northern hardwood stands of the Lake States have demonstrated that acceleration of increment follows partial cutting, and that mortality is low where the cut is not excessive (5,6). Economic obstacles to partial cutting on the Allegheny Plateau have been discussed by Ehrhart (3). On the Allegheny National Forest, sales involving the removal of amounts down to five or ten cords per acre have shown the practicability of light cuts under favorable conditions.

At present, salvage operations in glaze-damaged stands on the Allegheny Plateau are affording a good opportunity for the application of partial cutting. Except where necessitated by severe damage, complete removal of the immature second growth is a mistake.

Summary

In the birch-beech-maple-hemlock type of northwestern Pennsylvania, close utilization has led to the adoption of clear cutting as the standard practice. Culled old-growth stands were very successfully regenerated by this method. However, when young second growth is cut clean for acid or pulp wood before an understory begins to form, the intermediate and tolerant hardwoods fail to seed in. Beech, sweet birch, and yellow birch are almost eliminated from many areas. Intolerant weed species come in abundantly. Black cherry increases somewhat over its proportion in the second growth, and bids fair to dominate the third-growth stands at the cutting age. The increase of black cherry under short-rotation management may prove unfortunate because stump sprouts of this species present a high breakage and ice damage hazard, are poor in form, and have characteristics which are considered the cause of high sprout decay hazard in other species.

The results of weeding in poor third-growth northern hardwoods hardly justify the effort. Weedings cannot take the place of proper cutting methods.

Further operation in the relatively young northern hardwoods stands of northwestern Pennsylvania should be limited to partial cuttings until the establishment of advance growth has been brought about. Partial cuttings will be needed to sustain the market, and they can be so managed as to result in a profitable diversification of products.

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ERRORS INVOLVED IN DETERMINING TREE VOLUMES BY THE PLANIMETER METHOD

By R. A. CHAPMAN

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Tree volumes are often determined by the planimeter method. The author shows that each operator has his own particular bias which produces variation in the values obtained. Methods are suggested to reduce the individual errors to a minimum.

SOME years ago the planimeter method of determining tree volume was discussed in the JOURNAL OF FORESTRY[1] and the tree volumes obtained by this method and those obtained by the use of Smalian's formula were compared. In this discussion, however, no reference was made to errors introduced by the individual bias of the operator.

In an effort to obtain an estimate of the importance of these errors, the following test was devised: Each of the three curves of tree taper shown in Figure 1 was planimetered 16 times by 8 different persons and the results recorded in square inches. Four of the persons were experienced in operating the planimeter, and the other four were not. To avoid errors in setting the planimeter, the same instrument was used by each person.

The data for each tree were analyzed by Fisher's[2] method of analysis of variance. The results are shown in Table 1.

It is of interest to compare the mean squares for variation within an experience group with that for error. This shows that for trees Nos. 1 and 3 the variation within groups is larger than that for error. In both cases the probability (P) that the difference in mean squares is due to chance is less than 0.01. In other words, each operator has a definite bias. For tree No. 2, P is a little less than 0.05; the low value here appears to be associated with the shape of the curve. If the curve is smooth, each operator tends to get the same value within chance fluctuations; if the curve is not smooth, there is a definite bias.

The test of the importance of experience is made by comparing the mean square for variation between experience groups with the mean square for variation within experience groups. In no case does P reach 0.05, the usually accepted level of significance.

TABLE 1

ANALYSIS OF VARIANCE OF PLANIMETER READINGS FOR INDIVIDUAL TREES

Source of variation	Degrees of freedom	Sum of squares	Mean square	*F*
	Tree number 1			
Experience group	1	.0046	.0046	2.15
Within experience groups	6	.7341	.1224	12.36
Error	120	1.1938	.0099	
Total	127	1.9325		
	Tree number 2			
Experience group	1	.0312	.0312	4.46
Within experience groups	6	.0908	.0151	2.16
Error	120	.8386	.0070	
Total	127	.9606		
	Tree number 3			
Experience group	1	.0007	.0007	2.71
Within experience groups	6	.1163	.0194	10.21
Error	120	.2271	.0019	
Total	127	.3441		

[1]Winters, R. K., and P. R. Wheeler. The suitability of Reineke's planimeter method for volume determinations of delta hardwood species. Jour. For. 30:429-434, illus. 1932.

[2]For a discussion of this method, see "Statistical methods for research workers," by R. A Fisher, or "The methods of statistics," by H. C. L. Tippett.

The analyses shown in Table 2, show that an individual error of planimetering is correlated with the area under the curve.

TABLE 2

RELATIONSHIP BETWEEN ERROR AND THE MEAN AREA UNDER THE CURVE, BY INDIVIDUAL TREES

Item	Tree No. 1	Tree No. 2	Tree No. 3
Mean area in square inches	16.5921	8.9883	3.8005
Error[1]	.0995	.0869	.0436
Percentage of mean	.60	.96	1.15
Error[2]	.3499	.1229	.1398
Percentage of mean	2.11	1.37	3.66

[1]Standard deviation from error term in Table 1 (Example: $.0995 = \sqrt{.0099}$).
[2]Standard deviation computed from the variation among individuals, or within experience groups, in Table 1 (Example: $.3499 = \sqrt{.1224}$).

The common practice in planimetering is to trace the curve until two successive readings agree within 1 per cent. On the basis of the values in Table 2, the probability of an error of 1 per cent of the mean or larger in 1, 2, 3, or 4 readings may be readily computed. For tree No. 1, for example, the mean area is 16.5921 square inches, and 1 per cent of this is 0.165921. Using the error of 0.0995, the t value for 1 reading is $\frac{0.165921}{0.0995} = 1.67$. Referring to Pearson's tables of the normal probability curve, the probability of getting a value larger than $\pm t$ is 0.0950. Table 3 gives the probabilities for errors of 1 per cent or larger for each tree for 1, 2, 3, and 4 readings, respectively.

Table 4, in a form similar to Table 3 and constructed by using the standard deviation as estimated from variations among individuals, shows that, even with four people planimetering the curve, the probability of getting an error of at least 1 per cent is relatively great.

TABLE 3

PROBABILITY OF ERROR, BY NUMBER OF READINGS

Number of readings	Probability[1] of error at least as large as 1 per cent of the mean: Tree No. 1	Tree No. 2	Tree No. 3
1	.0950	.2938	.3844
2	.0182	.1388	.2186
3	.0038	.0702	.1310
4	.0008	.0366	.0819

[1]Based on the standard deviation of individuals (first "error" in Table 2).

TABLE 4

PROBABILITY OF ERROR, BY NUMBER OF READINGS

Number of readings	Probability[1] of an error at least 1 per cent of the mean: Tree No. 1	Tree No. 2	Tree No. 3
1	.6384	.4654	.7872
2	.5028	.3030	.6966
3	.4122	.2040	.6384
4	.3422	.1442	.5824

[1]Based on the standard deviation among individuals (second "error" in Table 2).

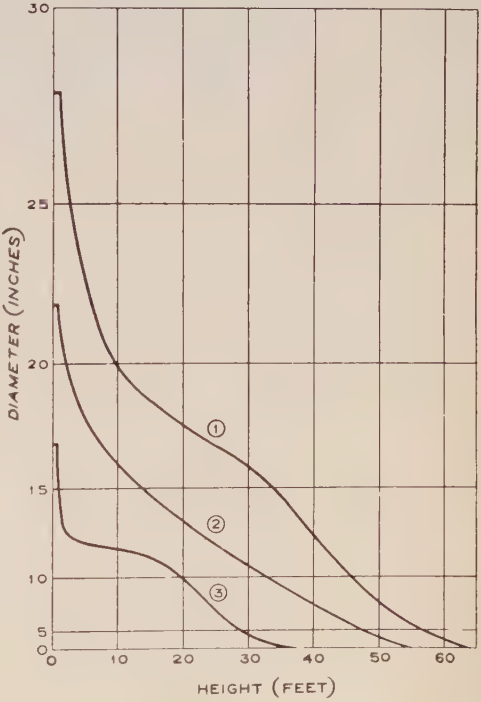

Fig. 1.—Taper curves.

The importance of considering the bias of individual operators can best be shown by considering the expression $\sigma_T^2 = \sigma_I^2 + \frac{\sigma_E^2}{N}$ where σ_T = the standard deviation of the total error of planimetering, σ_I = standard deviation of the individual bias, and σ_E = standard deviation of the readings made by the same person. If an operator makes a large number of readings, he can reduce $\frac{\sigma_E^2}{N}$ to a very small value; but even if this value becomes small, σ_I still remaines an appreciable amount. In other words, increased accuracy of an individual operator does not eliminate his individual bias.

If these data can be considered as typical of planimeter readings, it may be concluded from Table 1 that each individual operator has his own particular bias which produces variation, no matter on what scale the curve is plotted. Table 2 indicates that it is best to plot the taper curves on the largest possible scale, and from Tables 3 and 4 we find that, if very accurate estimates of area are essential, it is advisable to have several people planimeter each figure.

I. T. BODE, a Senior member of the Society, has been appointed Director of Conservation in Missouri with headquarters in Jefferson City, effective November 15. Until his recent appointment, Mr. Bode had been with the Bureau of the Biological Survey, U. S. Department of Agriculture, in Washington, D. C. He obtained his B.S. degree in Forestry in 1915, and his M.S. degree in Forestry in 1920, from Iowa State College. Prior to joining the Biological Survey Mr. Bode had been an Extension Forester for Iowa from 1921 to 1931, when he was appointed Director of the Iowa Fish and Game Department.

ELLERY FOSTER, a Junior member of the Society of American Foresters, was appointed director of forestry in Minnesota, November 4, 1937. Foster had formerly been chief of the Division of National Forest Planning, U. S. Forest Service, Washington, D. C. He was graduated from the University of Minnesota with the B.S.F. degree in 1927.

DR. LEWIS M. TURNER has resigned his position as assistant professor in forestry at the University of Arkansas and has taken up his work as associate conservationist with the Southern Forest Experiment Station, New Orleans. While at Arkansas Dr. Turner carried on research in many phases of forest ecology. One of his outstanding contributions to southern forestry is his pioneer work in studying the relationships between soil types and site index, growth and yields of shortleaf and loblolly pine. At the Southern Station, Dr. Turner will work in the flood control program.

A PROGRESS REPORT ON LABORATORY TESTS OF THE RELATIVE DURABILITY OF DIFFERENT VARIETIES OF BLACK LOCUST SUBJECTED TO CERTAIN WOOD DECAY FUNGI

By RAY R. HIRT

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Evidence is submitted that the heartwood of shipmast locust, a variety of *Robinia pseudoacacia*, is more resistant to decay by certain fungi in laboratory tests than the heartwood of the common black locust.

A VARIETY of the common black locust known as shipmast locust has recently been given the scientific name *Robinia pseudoacacia* var. *rectissima* Raber.[1] On Long Island, N. Y., where shipmast locust is common, the wood of this variety is considered to be more durable in contact with soil (as fence posts) than is the wood of the common black locust grown in the same locality.[2,3] Because of this and other desirable characteristics, shipmast locust has recently received consideration as a tree favorable for soil-conservation purposes. Black locust is also of great value as a farm tree throughout a wide range in this country, thus it is important that studies be made which will assist in the selection of the most favorable strains or varieties in respect to their growth qualities and resistance to fungus and insect pests. One investigation of this nature has already been undertaken.[4]

The suggestion was made to the writer by Dr. Henry Hopp, Soil Conservation Service, U. S. Department of Agriculture, that laboratory tests of the relative durability of shipmast locust would be desirable. Consequently this study was made preliminary to further studies on the durability of shipmast locust in comparison with the wood of common black locust from various localities.

METHODS

Three-foot sections from the freshly cut trunk of a common black locust and of a shipmast locust were secured in the vicinity of Huntington, Long Island. Fifty one-inch cubes of the heartwood were cut from each of the two varieties of locust. These blocks were placed in a drying oven at 104° C. until they reached a constant weight. Following the last weighing, the blocks were placed in the drying oven for 24 hours longer in order to kill any fungous spores that might have lodged on the surface of the blocks during the process of weighing. They were not subjected to moist sterilization. The blocks were then placed in cold sterilized distilled water and aspirated for two hours, after which they were immersed in the same water for 16 hours. Proper precautions were taken to prevent contamination of the blocks by fungous spores. The blocks of wood from shipmast locust and the common black locust were kept separated from one another while being prepared for the wood decay studies.

Meanwhile pure cultures of four different fungi were established in wide-

[1]Raber, O. Shipmast locust, a valuable undescribed variety of *Robinia pseudoacacia*. U. S. Dept. Agr. Circ. 379. 1936.

[2]Detwiler, S. B. The history of shipmast locust. Jour. For. 35:709-712. 1937.

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Table 1

LOSS OF WEIGHT IN COMPARATIVE TESTS ON HEARTWOOD BLOCKS OF COMMON BLACK LOCUST AND OF SHIPMAST LOCUST SUBJECTED TO DECAY BY FOUR DIFFERENT FUNGI FOR A PERIOD OF FIVE MONTHS

Fungus	Culture number	Black locust			Shipmast locust		
		Block No.	Loss Grams	Loss Per cent	Block No.	Loss Grams	Loss Per cent
Polyporus robinio-philus	1	101	0.210	2.05	1	0.00	0.00
		102	0.605	5.65	2	0.00	0.00
	2	103	0.638	5.71	3	0.00	0.00
		104	0.150	1.31	4	0.00	0.00
	3	105	0.539	4.89	5	0.00	0.00
		109	0.035	0.29	6	0.00	0.00
	4	107	0.262	2.34	7	0.15	0.14
		108	0.790	7.55	8	0.00	0.00
	5	106	0.505	4.13	9	0.00	0.00
		110	0.630	5.94	10	0.00	0.00
	Average		0.436	3.99		0.02	0.01
Fomes igniarius	1	116	0.279	2.78	16	0.00	0.00
		117	0.119	1.03	17	0.00	0.00
	2	115	0.116	1.02	23	0.04	0.35
		119	0.070	0.65	24	0.04	0.36
	3	120	0.620	6.01	25	0.00	0.00
		121	0.095	0.85	26	0.00	0.00
	4	122	0.140	1.28	27	0.00	0.00
		123	0.260	2.45	28	0.00	0.00
	5	124	0.440	4.36	29	0.00	0.00
		125	0.220	1.95	30	0 00	0.00
	Average	----	0.236	2.24		0.01	0.07
Poria incrassata	1	131	4.790	41.36	31	0.230	1.95
		132	2.356	19.96	32	0.350	3.08
	2	133	4.410	39.65	33	0.560	4.40
		134	4.420	40.41	34	0.235	2.12
	3	135	4.326	45.12	35	0.165	1.50
		136	1.860	14.72	36	0.178	1.67
	4	137	2.785	24.06	37	0.110	0.99
		138	4.240	46.13	38	0.350	3.25
	5	139	4.080	37.32	39	0.098	0.92
		140	2.658	24.50	40	0.340	3.19
	Average		3.592	33.32		0.262	2.31
Fomes rimosus	1	146	1.140	10.21	46	0.00	0.00
		147	0.817	7.09	47	0.00	0.00
	2	148	1.709	17.47	48	0.03	0.25
		149	0.639	6.11	49	0.03	0.25
	3	150	0.470	4.54	50	0.00	0.00
		151	1.040	10.56	51	0.00	0.00
	4	152	0.214	1.91	52	0.03	0.28
		153	1.960	17.01	53	0.00	0.00
	5	154	1.130	11.04	54	0.01	0.10
		155	0.040	0.36	55	0.00	0.00
	Average		0.916	8.63		0.01	0.09
Control	1 & 2	141	0.000	0.00	41	0.00	0.00
		142	0.000	0.00	42	0.01	0.10
No fungus		143	0.000	0.00	43	0.00	0.00
		144	0.000	0.00	44	0.00	0.00
		145	0.000	0.00	45	0.00	0.00
	Average		0.000	0.00		0.00	0.02

mouth Erlenmeyer flasks of one liter capacity. Two glass vials to support the wood blocks were placed horizontally on the bottom of each of 22 flasks and malt agar was added until the surface of the nutrient agar was slightly below the upper surface of the vials. After the agar was sterilized, five cultures each were made from the four species of fungi chosen for this study. Two flasks were kept as controls; no fungus being planted on the agar in either flask. The cultures were begun sufficiently early so that a mat of mycelium was present over the surface of the agar in each of the 20 culture flasks at the time the wood blocks were aspirated.

In each of the 20 culture flasks, two blocks each of common black locust and shipmast locust were placed so that they rested upon the glass vials but did not come in contact with the agar or with each other. In one control flask, five blocks of shipmast locust were placed and in the other control flask five blocks of the common black locust. The flasks containing the wood blocks were then kept in an incubator for five months at 28° C., after which the blocks were removed from the culture flasks, oven dried to a constant weight, and their weights determined.

The four fungi selected for these tests were: *Polyporus robiniophilus* (Murr.) Lloyd; *Fomes rimosus* (Berk.) Cooke; *Fomes igniarius* (L.) Gill.; and *Poria incrassata* (Berk. and Curt.) Burt. The first two fungi are commonly found upon living locust trees; the third is one of the most destructive fungi of broad leaf trees, both living and dead; and the fourth is an important dry-rot fungus of structural timbers.

Results

During the interval of incubation, the mycelia of the fungi grew completely over the blocks. There was no difference in the growth of the mycelium on the blocks of the two varieties of locust except in the cultures of *Polyporus robiniophilus;* in these cultures the blocks of shipmast locust definitely supported a sparser growth of the mycelium than the blocks of the common black locust.

When the blocks were taken from the flasks the mycelium was carefully removed from the surface of each block. The wood of the common black locust was distinctly discolored, being lighter in color than normal except in those blocks attacked by *Poria incrassata,* the wood of which was deep brown in color, checked, and very brittle. The shipmast locust subjected to this fungus showed similar evidence of decay.

The losses in grams and in per cent of the oven-dry weights are recorded in Table 1. Whereas common black locust was decayed by each of the four fungi, only *Poria incrassata* had any significant effect upon shipmast locust. Even with this fungus the loss through decay as expressed in per cent loss of weight was considerably less than for the common black locust.

Conclusion

With the samples studied, the wood of shipmast locust was apparently more durable than that of common black locust. It is not known yet whether the same relative results will apply to common black locust wood obtained from other localities. This aspect will be considered in other tests now being planned.

FROZEN ASSESSMENTS AND THE PREPAID YIELD TAX

By R. CLIFFORD HALL

U. S. Forest Service

The forest-taxation proposals of Matthews are critically discussed from the viewpoint of principles developed in the Forest Service studies of this subject. The workability of these proposals is questioned. It is suggested that the best chance of progress in forest taxation is to hinge desired changes on to existing taxation practices and concepts.

A PROGRAM of forest taxation has been proposed by Matthews in his book "Management of American Forests" (4, Chap. XVIII, pp. 377-412). In the case of operating properties, this program would involve freezing the property-tax assessment; that is, retaining the initial value as the basis for taxation throughout the depletion period independent of changes in timber volume. In the case of immature second-growth forests, it would require the substitution for the property tax of a form of yield tax. These measures differ materially from those proposed by the Forest Service in "Forest Taxation in the United States" (3, pp. 539-640). An analysis of Matthews' proposals from the viewpoint of the principles developed in the Forest Service taxation studies may serve to clarify some aspects of the forest-tax problem.

In order to prevent misunderstanding, it should be explained that in this article the term value, unless quoted, is used in the recognized legal sense as defined in constitutional and legislative provisions governing taxation and in related court decisions. The meaning of value thus established in law corresponds to that recognized by most economists, except that it is always expressed in terms of money rather than of some other good. Therefore, as used here, the value of anything is the amount of money that would be exchanged for it in a free market without any element of compulsion. In this sense a property can have only one value at one time. This value is independent of any particular use of the property or purpose of the owner, being based upon the most profitable of the various possible uses. If the owner intends to put the property to some less profitable use, that is his right, but such intention does not affect its value. However, value may be influenced by such effective limitations on use as may be prescribed by law or tradition.

In this discussion, it will be convenient to classify forest properties in accordance with the nature of their income streams as depletion, sustained-yield, and deferred-yield, depending on whether the realized annual income is greater than, equals, or is less than the interest on the capital value. It will also be useful to recognize two sub-classes of deferred-yield forests. Forests which cannot at the present time be cut profitably by reason of inaccessibility, inferior species, or any condition other than physical immaturity, will be called deferred-yield old-growth forests. Where yield is deferred during a period of growth as in the case of cutover lands and immature stands, the term deferred-yield second-growth forests will be used. A more detailed explanation of this classification is presented in "Forest Taxation in the United States" (3, pp. 40-49).

Practical Considerations

Before discussing the theoretical approach to the measures proposed by Matthews, it would seem worthwhile to first give attention to their practical aspects. Workability is a prime essential in any plan of taxation. Also, a clear understanding of how these measures would apply to the above-mentioned forest-prop-

erty classes may be helpful to a study of the theory involved.

Depletion Forests.—It is proposed by Matthews that depletion forests be assessed in accordance with their initial values at the beginning of their respective liquidation periods, each such assessment to remain frozen throughout the entire period of operation. No change in the assessment would be made for reduction in volume of timber, although readjustment to take account of unforeseen changes in stumpage prices, in tax rates, or in plan of operation would be permitted. The initial values, according to this plan, would be determined by discounting prospective annual income, allowing for taxes by adding the tax rate to the interest rate to obtain the rate of discount. The discount method suggested would make use of a formula developed by mining engineers as a guide to the appraisal of mining properties (Cf. 1, pp. 116, 136-138). This formula, known as Hoskold's, is used in absence of better evidence by state tax commissions and the federal Income Tax Unit in the valuation of ore deposits, and has been recognized for that purpose by the courts. It is based on the theory that the initial investment in a wasting asset may be regarded as remaining intact as an interest bearing instrument throughout the liquidation period, at the end of which it is repaid to the investor from a sinking fund established out of earnings by equal annual payments accumulated at interest. As used by Matthews (4, p. 396) the remainder of each annual income, after ordinary expenses, would be divided between interest and taxes, both based *on the theoretical constant investment* at fixed rates, assumed in his examples to be 6 per cent and 1½ per cent respectively.

Whatever the merits of this or any other form of discount formula may be for finding the value of forest property (Cf. 3, p. 544), it is clear that such a discount process would not indicate value unless the sum discounted consisted of income expected *subsequent* to the date of valuation. When used in the appraisal of mines for taxation and other purposes the value at any date is thus determined on the basis of expected income subsequent to that date. Frozen assessment is no part of mine taxation in any state.[1] The assessment fixed as here proposed could represent the value of the property only at the beginning of the liquidating period. When a part of the property, whether it be timber or any other valuable resource, is removed, the value of the property is correspondingly reduced, and under the property tax only the value actually remaining is taxable. This fact seems to have been overlooked in stating that the method "could apparently be adopted.... without constitutional amendment or legislative action, as the best method of determining the cash value of forest properties" (4, p. 398). The revolutionary feature of this plan is not the use of the discount principle in determining assessed value, but the fact that the assessed value would remain unaffected by the decline in actual value of the property.

Consider the situation in Matthews' example of a forest under liquidation over a 20-year period (4, p. 396). At the beginning of the twentieth year the owner would possess a property which would be expected to return at the end of that year the sum of $163,320 less a property tax of $23,970, or $139,350. Surely no one would contend that a property with a total expected net income of $139,350 could properly be held to have a cash value equal to the frozen assessment of $1,598,-000. Discounting the expected net income in the ordinary way at 6 per cent, the value of this property at the beginning of

[1]For an authoritative description of the Michigan mine appraisal system cited by Matthews (4, p. 394), the reader is referred to Appendix A of "Mine Examination and Appraisal" (1, pp. 276-293).

the twentieth year would actually be about $131,462. The tax based on the frozen assessment would take over 18 per cent of this value, in contrast to the assumed general property-tax rate of 1½ per cent.

Regardless of other aspects of frozen assessments, the practical difficulties in the way of thus upsetting all property-tax theory and practice as crystallized in constitutions, laws, and court decisions, appear insuperable. In most states an amendment of the constitution would be required to validate such inequality in property taxation, for even where there is a classified property tax the intention of the owner to practice a particular kind of forest management would not ordinarily be an allowable basis for recognizing a distinct class taxable at a special rate. In all states the popular idea of equity in property taxation would have to be radically revised to admit of this method.

If the constitutional hurdle could be passed other difficulties would be encountered. As Matthews himself suggests (4, p. 398), centralization of forest-land assessment in a state authority would be necessary. This is a desirable measure in itself, apart from any particular forest-tax plan, but one which is at present politically impossible in most states. Authority to centralize assessment of timber was sought under favorable auspices at the recent legislative session in Oregon, but without success.

Another legislative difficulty is that this plan would never be voluntarily accepted by owners of liquidating forests because it would increase their tax burdens above what they would be under the unmodified property tax. A mandatory law would be necessary to make the plan effective. Such a law would be opposed vigorously not only by timber operators but by owners of mines and other depletable resources who would fear the application of the same principle to their properties. So far the short-term timber operators have been able to defeat all attempts to increase their tax burdens by substituting a mandatory yield tax for the property tax on old-growth timber. It is safe to say that with the aid of owners of other natural resources they could prevent the enactment of any effective form of frozen assessment.

Certain administrative aspects also deserve consideration. The necessity is evident of apportioning the total assessment obtained by application of the proposed formula to the property as a whole among the several taxing districts in which that property is located. Matthews suggests that "the annual taxes should be distributed to each township in proportion to the area or volume located in that township, irrespective of where the cutting is done in any given year" (4, p. 399). If the property were in several different districts having different tax rates, how could the total annual taxes be determined without first apportioning the assessment? These different tax rates could not be ignored without upsetting normal budgetary procedure. If the assessment, rather than the taxes, were apportioned as proposed, a material difference in result would usually exist between a distribution based on area and one based on volume. If one is equitable the same could hardly be true of the other. Certainly neither one would be satisfactory to the other taxpayers in the districts affected without a revolution in existing concepts of tax equity, since the tax revenue in any year would have no consistent relation to the value of the property located in the taxing district on the assessment date.

Another practical difficulty in the operation of the proposed treatment of depletion forests is that repeated revision of each assessment would be necessary (4, p. 400). There would be changes in current and expected stumpage prices and in management plans, to say nothing of variations in tax rates from year to year and from district to district, all to be

reflected back in a "value" at the beginning of cutting. The date of the assessed valuation would become more remote as the years went by, with intervening changes making its calculation more complex and uncertain.

Sustained-yield Forests.—It is proposed by Matthews to determine the value of annual sustained-yield forests by capitalizing the "annual income from stumpage," the rate of capitalization being the interest rate plus the tax rate (4, pp. 397-398). If the term "annual income from stumpage" means expected annual net income after all expenses except the property tax, and if the interest rate used for purpose of capitalization correctly represents the practice of buyers and sellers of forest property, the resulting amount would presumably be the actual cash value which would be determined under a properly administered property tax of the ordinary type. Therefore, no change in existing property-tax law would appear necessary to Matthews' program so far as annual sustained-yield forests are concerned. Matthews assumes (4, p. 382) that the assessor would assess such a forest not only illegally but also at a much higher figure than actual value. The evidence obtained by the Forest Service in its taxation studies indicates that the assessment on a valuable forest property such as the one portrayed in the example would be more likely to be low than high, relative to actual value. Over-assessment of high-priced forest property was found only in occasional districts (3, p. 144).

It is not clear why Matthews does not propose that periodic sustained-yield forests, as well as annual sustained-yield and depletion forests, be taxed on the basis of frozen assessments. The formula given for finding the value of such a forest at the beginning of the income cycle would produce a "freezable" assessment which could be made subject to the property-tax rate as in the example given (4, p. 405). The application of frozen assessments to periodic sustained-yield forests would, of course, involve some of the same difficulties pointed out in the case of liquidating forests. Practically the same tax burden would result through the operation of the adjusted property tax or the deferred timber tax plans recommended by the Forest Service, providing the basic assessments were determined with reasonable accuracy in accordance with the principles now established by law.

Deferred-yield Forests.—Matthews proposes that deferred-yield second-growth forests be subject to a yield tax from which would be deducted annual taxes paid in advance of the receipt of the yield, together with compound interest on such taxes computed at a savings bank rate (4, pp. 410-411). As will be explained at a later point, it is mathematically impossible to determine a uniform rate for a yield tax which, without any annual tax, would impose on different forests an approximately equitable burden. Also, the suggested device of crediting current annual taxes against the yield tax would be difficult of application. How would an annual tax be determined which would be adequate from the local viewpoint without forcing the owner to greatly overpay the yield tax? Proper accounting through long periods of time with ownership and other changes would be complicated and subject to error. The treatment of other income from multiple use forest properties would also be in doubt. Other difficulties generally involved in the application of the yield tax are fully discussed elsewhere (3, pp. 560-576).

No specific proposal has been made by Matthews for any modification of the existing tax status of deferred-yield old-growth forests. However, the Forest Service has found that the management of such forests is affected unfavorably both by the imperfect operation of the property tax—

especially erratic assessment—and by its inherent nature (3, pp. 522-527).

Theoretical Approach

Having considered the practical operation of the forest-tax proposals under discussion, it is now in order to examine their theoretical foundation.

The standard of an equitable property tax burden on forests is stated by Matthews thus: "A tax on property should, if equitable, take the same proportion of income derivable from property in all cases" (4, p. 378). Apparently this would not differ from the standard adopted by the Forest Service which is "the ordinary tax on net income, being that form of taxation under which tax payments obviously conform most closely to the flow of income" (3, p. 576).

Leading up to the proposal for frozen assessments, the belief is expressed "that the principle of the general property tax can be applied with perfect propriety to all forms of forest property that produce annual incomes if and when the true value of such property is determined upon an equitable basis" (4, p. 392). Here again there would be no conflict with the Forest Service position if "true value" were taken to mean value in the legal and economic sense, except for the limitation to forest properties producing annual incomes. This limitation would restrict the application of the principle to annual sustained yield and depletion forests.

The yield tax is recommended "for properties that are of such a nature that only deferred incomes can be expected from them" (4, p. 393). It is argued that property subject to deferred or intermittent income "has, just after any income is received, a very low value; and the application of the general property tax principle to such values, while mathematically correct, would result in such low tax revenues as to be generally unacceptable" (4, p. 392).

Here is an important departure from the fundamental idea, promulgated both by Matthews and the Forest Service, of adapting the property tax on forest property to the nature of the income stream. The only reason given for this departure is the low annual tax under an appropriately modified property tax. It is not shown, however, that the proposed substitute, an annual payment as an advance on a yield tax, would be materially higher.

This departure from the property tax is defended on the ground that by applying the yield tax in the manner suggested it would give deferred-yield forests parity, in accordance with the income tax principle, with properties yielding a regular annual income (4, pp. 393, 404-406). However, the fact is that the proposed yield-tax rate, calculated as the per cent of property tax rate to capitalizing rate (4, p. 411), would impose a heavier burden than the corresponding property tax would impose on income bearing properties. It would give parity only if the stumpage values to which this rate applied represented net income before taxes; that is, only if it were possible to grow timber without incurring any annual expense except taxes. This method of calculating the yield-tax rate was proposed by Fairchild in 1909 (2, pp. 616-617, 623), based on a theory which did not clearly distinguish between yield, as this term is used by foresters, and net income, and which theory was therefore revised in the later studies under his direction. In fact, a uniform yield tax rate which would give the desired parity among different properties is an impossibility, as shown by the formula developed in these later studies (3, p. 72, formula 18) for determining the portion of net income before taxes taken by a pure yield tax. Since this formula contains terms representing cost of regeneration and annual expenses, items which are in variable relationship to the other terms when different properties are involved, a uniform rate of yield tax would take a

different portion of income before taxes in different cases. Therefore, the yield tax as proposed is mathematically incompatible with the stated objective.

As noted before, there is no specific recommendation in reference to the taxation of deferred-yield old-growth forests. There appears to be no theoretical ground for this omission, if the standard of an equitable property tax burden on forests as stated either by Matthews or by the Forest Service is accepted as generally valid.

Comparing the theoretical aspects of Matthews' approach with that of the Forest Service, it is noteworthy that the fundamental objectives are the same. Both agree that the theoretically perfect tax on forest property would take the same portion of income derivable from its future use regardless of the type of income stream. Such a tax would impose no handicap on forestry where the use of the land for forestry comes into competition with other uses which promise earlier returns. Thus the significant differences between Matthews' proposals and those of the Forest Service, aside from the question of determining a proper rate for the yield tax, are in the realm of practice rather than of theory.

Summary and Concluding Statement

The forest-tax program proposed by Matthews involves retention of the unmodified property tax on deferred-yield old-growth and its retention in principle on annual sustained-yield forests; freezing of the initial assessment on depletion forests so that they will be taxed more heavily than under the usual property tax; and the application of a yield tax partly or wholly prepaid in annual installments to periodic sustained yield and to deferred-yield second-growth forests. It also prescribes formulas for determining assessed value; for depletion forests by discounting expected future earnings to the beginning of the cutting period in accordance with a management plan which would be filed by the taxpayer; for annual sustained-yield forests by capitalizing net incomes. This program is not concerned with fundamental questions of local government and land-use policies as affecting the total burden of the property tax on real estate in forest regions.

The reasoning upon which this program appears to rest may be stated briefly as follows:

(1) Depletion forests enjoy a tax advantage over annual sustained-yield and deferred-yield forests which ought to be removed.

(2) Annual sustained-yield forests are likely to be overassessed under the property tax and therefore special provision for their assessment is required.

(3) The existing tax status of deferred-yield old-growth forests need not be changed.

(4) Periodic sustained-yield and deferred-yield second-growth forests cannot be satisfactorily taxed under the property tax system and accordingly a yield tax should be substituted, any annual payments required for current support of government being treated as interest-bearing installments in prepayment of the yield tax; the rate of the yield tax to be fixed in such a manner as to impose a burden equivalent to that of an income tax.

The position on these points taken in this article, guided by the Forest Service studies on taxation, may be summarized as follows:

(1) It is questionable whether the tax advantage which depletion forests enjoy under the property tax is of itself a sufficient inducement to destructive cutting to justify attempting the difficult task of counteracting it by the imposition of an additional tax burden. Considerations chiefly of a practical nature point to the desirability of continuing the unmodified property tax on depletion forests.

(2) Studies of actual assessment practice indicate a probability that annual

sustained-yield forests would not be generally overassessed under the property tax. If such a situation should arise, and if existing remedies at law should prove inadequate, it would then be in order to devise effective means of obtaining a lawful assessment.

(3) Deferred-yield old-growth forests are subject, even under a correctly administered property tax, to an excess burden over that imposed on property which yields a regular annual income. They may also be subject to erratic assessment or other administrative abuses. It is important to remove the handicaps imposed on such forests both by the legal and illegal operation of the property tax. This step, by destroying the tax incentive to premature cutting, would encourage holding the timber for orderly marketing and would facilitate ultimate conversion of the forest to sustained-yield management.

(4) It is impracticable to determine a yield-tax rate which will, in the majority of cases, result in a burden similar to that of the property tax on property which yields a regular annual income. The proposed method of determining the rate, by ignoring expenses of growing timber, would impose an excessive tax burden measured by the income tax standard. Serious administrative difficulties are also involved in the yield tax as here proposed.

In conclusion it may be well to point out that the practical difficulties connected with classifying forests into three different types to be taxed under three different methods, each with its administrative complications, would be great. It is difficult enough to obtain proper administration of the property tax without separating out two classes of forests, one to be taxed on frozen assessments determined by a discount process, and another to be taxed solely on the basis of yield, but with part payment annually. The constitutional, legislative, and administrative obstacles in the way of carrying out this program cast grave doubt on its workability.

Progress in obtaining *any* better method of forest taxation is likely to be slow under the democratic form of government. It would seem the part of wisdom to hinge desired changes on to existing practices and concepts rather than to depend on directly upsetting such basic principles as assessment in accordance with actual value and taxation of the bulk of real estate under the property tax. While the special forest tax measures recommended by the Forest Service depend for full effectiveness upon radical improvements in assessment designed to make existing practice correspond to the recognized theory, they do not need to wait for realization of such improvements. They would ameliorate the existing forest tax situation even if applied in connection with present faulty assessment practice. It also should be emphasized that fundamental correction of this situation is in most states dependent upon changes in governmental organization, in control of settlement, and in local public finance, to the end that the weight of property taxation in forested districts may be equitably adjusted with due consideration for the governmental needs and tax-paying ability of such districts.

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GLAZE DAMAGE IN THE BIRCH-BEECH-MAPLE-HEMLOCK TYPE OF PENNSYLVANIA AND NEW YORK

By ALBERT A. DOWNS

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The glaze storm of March 17-19, 1936, damaged the forest on six million acres in Pennsylvania and New York. Immediate losses of forest products will be considerable due to the inability of the market to absorb all salvageable material before it decays. Future losses will take the form of decreased volume growth, resulting from destruction of crowns and opening the stand to soil desiccation; and decreased quality growth, resulting from deformity, ravages of rot and insects, and entrance of weed trees into the stands. Tables and graphs show that damage increases with increase in size of tree; in age of the stand; and in elevation of the site. Southerly aspects suffered less than northerly ones. Because of their greater flexibility and manner of growth conifers as a whole were more resistant to glaze injury than hardwoods. The existing situation should be met by immediate salvage of damaged trees, and stand sanitation to minimize future losses. Measures to lessen damage from future glaze storms are synonymous with good silviculture, and the maintenance of a larger proportion of conifers where practicable.

FOR many years the forests on six million acres in Pennsylvania and New York state will bear the scars f their battle with the elements, and the sidents of this area will long recall the ashing of trees and branches weighted ith ice, during the severe glaze storm of arch 17-19, 1936. Originating in the uthwest, a cyclonic storm brought heavy recipitation to Pennsylvania and New ork during this three-day period. Wher-er temperatures hovered around the eezing point[2] the rain froze on all ob-acles. Twigs the size of a lead pencil cumulated ice up to a diameter of two three inches. The absence of wind revented what might have been a com-lete annihilation of tree growth in some calities.

In New York state an area of over 4 illion acres was damaged, a tract rough- bounded on the west by the Genesee iver, on the north by Monroe and Wayne ounties, and extending to the east as far Cortland and Tioga Counties. In north-estern Pennsylvania 2 million acres or more in Forest, Elk, Cameron, McKean, Potter, and Tioga Counties suffered severely. Practically all of the damaged area is included in the northern Allegheny Plateau with much of it lying above 1,500 feet in elevation. Throughout this area the birch-beech-maple-hemlock type predominates except in stream bottoms, around the Finger Lakes, and near Lake Ontario, where the chestnut-chestnut oak-yellow poplar type holds sway.

In New York state the area affected is largely composed of farm woodlots rather than extensive wooded areas. William Anderson of the Soil Conservation Service in New York state estimates that about 10 per cent of these woodlots are practically ruined, 5 per cent hardly damaged at all, and the remaining 85 per cent distributed between these extremes. A chemical company in Potter County, Pa., estimates that at least 50,000 cords of chemical wood went down and are *lying on the forest floor* of their holdings of 21,000 acres; and that probably one million cords were broken down in that county

[1]Maintained by the U. S. Department of Agriculture at Philadelphia, Pa., in cooperation with e University of Pennsylvania.

[2]Downs, A. A. Weather conditions during the glaze storm of March 17-19, 1936, in Penn-lvania and New York. Mo. Weath. Rev. 65:100-101, 1937.

alone. In addition great damage was done to standing trees. The Armstrong Forest Company, owning timberland in McKean, Elk, and Cameron Counties in Pennsylvania, made careful estimates of immediate damage on 10,533 acres. The average loss was 13.04 cords per acre, or a total of 137,317 cords of wood. With a glutting of the chemical and pulpwood markets practically certain, by no means can all of this material be salvaged before decay halts operations.

Beyond this immediate loss are others no less tangible although deferred: loss in volume growth because crowns are reduced, entire trees are removed from the stand, and the soil is exposed to desiccation; and in quality growth because trees are deformed, rot is allowed entrance,[3] and weed species may invade the stand. Another potential source of loss—insects—must not and is not likely to be overlooked.

The Kane Forest Study

The foregoing data were collected by correspondence and interviews. Detailed information for a single tract was obtained by the Allegheny Forest Experiment Station from a field cruise covering 2.6 per cent of 1,675 acres in the Kane Experimental Forest.[4] This area is in northwestern Elk County on the Allegheny National Forest south of Kane, Pa. Here, as in the usual mixed hardwood stands of northwestern Pennsylvania, black cherry is abundant in second growth, and both seedlings and sprouts of this species assume early dominance over the slower-growing tolerant species. The resulting stand is generally two-storied; black cherry forms a large-crowned overstory, while suppressed and intermediate sugar maple, yellow birch, and beech occupy subordinate positions and are of smaller size for the same age.

During the glaze-damage cruise all trees were tallied by species, diameter, and the following damage classes:

0. Undamaged trees
1. Minor damage to main top or bole
2. Top broken up badly or split off, injuring tree severely
3. Bole broken off entirely either in crown or below
4. Uprooted (whole or in part)
5. Bent but not broken or uprooted
6. Forked trees split at crotch

Trees in classes 2-6 inclusive were considered severely damaged and in need of salvage. In this article volume damage is computed on the basis of severely damaged trees only.

The object of this cruise was to determine the general area affected, the severity of the damage, the type and amount of damage, and the factors responsible for it. From these data have been formulated recommendations as to the type of silvicultural management which promises to minimize the damage from future glaze storms.

Age, Crown, and Diameter Class

Table 1 and Figure 1 show the terrific loss suffered in the greater part of the forest. For purposes of this study the stands were divided into 3 age classes: young growth (up to 20 years old), second growth (21 to 40 years old), and old growth (culled virgin timber). Older trees are scattered through some of the young growth, and "hold-overs" from the virgin forest are common in the second growth. Because of these irregularities and the relatively small number of trees in the larger diameters, the graphed points are somewhat erratic. and no attempt has been

[3]Possible future losses due to fungus infection are discussed by W. A. Campbell (2) in "Decay hazard resulting from ice damage to northern hardwoods." Jour. For. 35:1156-1158. 1937.

[4]Grateful acknowledgment is made to Assistant to Technician Camman Niederhof who was in charge of this cruise, and to Assistant Silviculturist A. F. Hough, who planned the glaze damage study.

nade to draw smooth curves through nem.

; The table also shows that glaze damage vas more serious in old growth and sec-nd growth than it was in stands of young rowth. Increase in size of crown, pres-nce of decay, and decrease in flexibility f bole and limbs appear to be factors ausing the greater loss in older stands. Both old-growth and second-growth trees ave larger amounts of relatively brittle eartwood in the boles and limbs than oung saplings. Severe damage in the maller diameter classes of the old-growth tand (Fig. 1) is also partly due to the alling upon them of ice-weighted branch-es and tops of larger trees. The culled ld-growth stand from which these data n Table 1 and Figure 1 were secured is ocated near an open field on a plateau ,000 to 2,060 feet in elevation; the effect f elevation on the severity of glaze dam-ge is discussed later.

The degree of damage to the individual ree is largely governed by its size and rown class. Damage increases with in-rease in size of tree, as Figure 1 shows or each of the three age classes. The rea-on for the crossing of the "curves" is hiefly variation in species composition nd dominance. It was noted that a pecies when dominant usually suffered nore damage than when it was in a lower rown class. For example, 18.0 per cent f the beech[5] in the second-growth stands vas injured, while in the culled old-growth stands, where it is more often dominant, the percentage of injured beeches is 55.3. Because of this tendency of the overstory to be damaged more than the understory, the young-growth damage curve at its upper end crosses the second-growth curve, which in its turn crosses the old-growth curve. The 4- and 6-inch classes are chiefly dominant black cherry in the young growth and therefore suffer a greater amount of damage than do the same diameter classes composed chiefly of intermediate sugar maple in the second-growth. Similarly the 14- and 16-inch classes are chiefly dominant black cherry in the second-growth but are subdominant sugar maple and beech in the old-growth. Reasons for the change in direction of the old-growth curve at the 12- and 14-inch classes are not known, but the number of trees sampled is rather low beyond the 10-inch d.b.h. class.

Figure 2 analyzes the damage in second-growth stands by the six classes in which the damaged trees were tallied. Curve 1 representing minor damage rises sharply to a peak at the 8-inch class and then slowly declines. Minor top damage gave way to severe damage in the larger diameter classes as shown by curve 2. Severe top damage increased as the tree became larger, more dominant, and more exposed. At about six inches the bole was least able to support the crown as shown in curve 3. Thereafter the size of the crown did not increase as rapidly as the

TABLE 1

GLAZE DAMAGE BY AGE CLASSES ON THE KANE EXPERIMENTAL FOREST, ELK COUNTY, PA.

Age class	Basis: number of trees[1]	Trees damaged	Trees severely damaged	Volume per acre: Total	Volume per acre: Severely damaged	
		Per cent	Per cent	Cords	Cords	Per cent
oung growth 10-20 yrs.	5,337	7.1	6.1	5.06	0.94	18.6
econd growth 21-40 yrs.	22,535	21.5	16.9	25.25	9.57	37.9
ld growth (culled)	675	39.4	29 0	27.70	18.96	68.4

[1]Based on a 2.6 per cent sample of 1,675 acres ranging from 1,700 to 2,090 feet in altitude.

[5]Nomenclature follows Sudworth, G. B. Check list of the forest trees of the United States: ieir names and ranges. U. S. Dept. of Agr. Misc. Circ. 92, 295 pp. 1927.

bole increased in strength and in ability to support a greater load. Uprooting as indicated by curve 4 was not a serious factor. Particularly striking is the large amount of bending damage in the smaller diameter classes (curve 5). Since damage classes 1, 2, and 3 are breakage injuries of one kind or another we may throw them together as breakage in contrast to bending injury. In the 2-inch class 84 per cent of the damage was due to bending and only 16 per cent to breakage; in the 4-inch class the two are nearly equal with bending damage still a bit greater, but from then on the situation is reversed and bending damage declines very rapidly while breakage damage leaps upward. The conclusion is that with increased size flexibility is reduced. Although rather spectacular to the casual observer, the splitting of forked trees at the crotch (curve 6) does not appear to be very serious. No data were collected on the relative number of forked and unforked black cherries (this species is very prone to fork), but splitting at the fork could not be a serious factor with only 13 trees thus damaged out of 2,180 black cherries tallied.

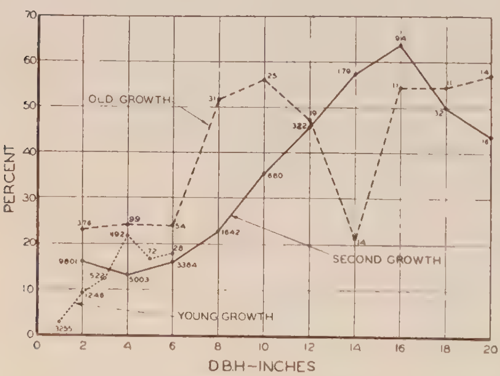


Fig. 1.—Severe damage (omitting class 1), by diameter. All tree species are included except eastern hemlock, which was eliminated in second-growth curve because the large amount of hold-over hemlock obscured upper trend of curve. No eastern hemlock present in virgin growth, and practically none in young growth. Basis: young growth 5,315 trees; second growth 21,153 trees; virgin growth (culled) 654 trees.

All the trends here noted for second-growth stands were likewise more or less evident in the young-growth and old-growth data.

Stand Density

An attempt was made to relate the percentage of trees severely damaged to the total number of trees and also the total basal area on each plot in order to determine whether stand density was an important factor in glaze damage. No definite trends were found in either young growth or second growth. The tendency for certain poorly stocked young-growth plots to be severely damaged was ascertained to be due to the fact that open grown black and pin cherry made up the majority of trees on such plots; both are species highly susceptible to breakage of all sorts.

Reports from New York state indicate that older second-growth stands which had been thinned suffered 15 per cent greater damage than unthinned stands. The question of possible increase in susceptibility to glaze damage created by thinning operations is important and information on this point will be secured by the remeasurement of a series of thinned and check plots established in 1932 by the Allegheny Forest Experiment Station on the Kane forest.

Species

Evidence indicates that tree species vary in their ability to resist glaze dam-

Table 2

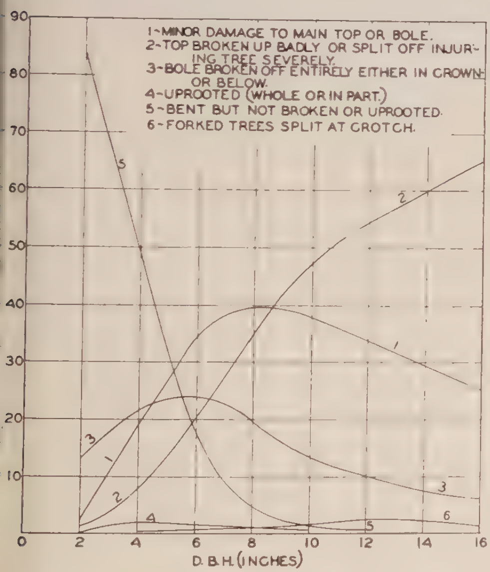
GLAZE DAMAGE BY SPECIES IN SECOND-GROWTH STANDS ON THE KANE EXPERIMENTAL FOREST, ELK COUNTY, PA.

Species	Basis: number of trees	Per cent damaged[1]	Per cent severely damaged[2]
Black cherry	2,180	59.4	41.0
Sweet birch	1,406	21.4	15.0
Red maple	2,131	20.4	16.0
Yellow birch	2,107	19.3	14.6
Beech	5,351	18.0	15.1
Sugar maple	7,566	17.2	15.1
Eastern hemlock	1,365	5.3	4.8

[1]Damage classes 1-6 inclusive.
[2]Damage classes 2-6 inclusive.

ge due partly to inherent characteristics. able 2 illustrates the susceptibility to amage of the important species found in ie second-growth well-stocked stands on ie Kane Experimental Forest. Two facts mmediately attract attention: the high ercentage of injury to black cherry and ie low percentage of injury to hemlock. lack cherry develops heartwood in both eedling and sprout growth when about 0 years old and is relatively brittle; it orges ahead of the other species to pro- ect above the general level of the crown anopy, and tends to spread its crown ito a wide round top. All of these in- erent species characteristics mark it for evere glaze damage, whether in pure ands or in mixtures.

As a check on the Kane Forest data, stimates of the relative resistance of arious species to glaze damage were ob- ained from a number of persons in New ork and Pennsylvania. It is not sur- rising that these estimates, based on ular observations or measured samples, were quite variable when one considers the factor of human judgment as well as the variety of topographic and forest conditions within the six million acre area. However, they indicate that we can separate the forest tree species into four broad classes in regard to resistance to glaze injury. Basswood, aspen, willow, and—at least in certain areas, such as the Kane Forest—black cherry, were unusually severely damaged. Although no hardwood uniformly escaped serious damage, sugar maple, white ash, oak, hickory, and sycamore weathered the storm fairly well. Distributed between these two groups were the rest of the hardwoods found in this region: red maple, beech, American elm, the birches, black locust, yellow poplar, cucumber magnolia, and black gum. Surprising as it may appear on first consideration, most observers agreed that the conifers, which here include northern white pine, eastern hemlock, Norway pine, spruce, and northern white cedar, suffered remarkably little from the storm even when compared to the most resistant hardwoods. Greater resilience of branches and younger stems (the Kane data reveal that while 13.9 per cent of the hardwoods in the class 1.0-2.9 inches suffered permanent bending damage, only 4.9 per cent of the hemlocks in the same class suffered a similar permanent deformity), branching habits better adapted mechanically to resist weight on their crowns, and generally smaller upper crowns, probably account for their superiority.[6]



ig. 2.—Damage analyzed by damage classes. ata from second-growth well-stocked stands. Based on 4,783 trees.

Changes in Stand Composition and Density

Following a storm such as this, changes in composition are likely, and decreases in density are practically certain. Table 3 shows the immediate change in composition by volume on badly-damaged areas within the Kane Experimental Forest; that is, stands above 1,900 feet in eleva-

[6]L. O. Bond of the Resettlement Administration in New York confirms these observations.

tion. Black cherry lost 41 per cent of its original percentage, allowing every other species to gain at its expense. Eastern hemlock with a 51 per cent gain and sugar maple with a 24 per cent gain of their original proportions, are the chief beneficiaries. In any northern hardwood stand containing eastern hemlock, regardless of composition, the relative amount of hemlock is likely to increase following a glaze storm, because it is most resistant to glaze damage. Whether the survivors of such a storm are able to hold their own against invasion of the stand by other species, particularly light-seeded ones, depends of course on their age, rate of growth, and tolerance.

More certain than changes in composition is a decrease in density occasioned by the storm. In second-growth stands above 1,900 feet there was a 20 per cent decrease in the number of stems, 27 per cent decrease in trees of the 6-inch class and larger, and a 43 per cent decrease in trees in and above the 10-inch class. A decrease in density of 20 per cent is a serious matter, particularly when a large number of the damaged trees are dominants. Their removal will leave large holes in the canopy and encourage remaining trees to become limby, large-topped, and poorly formed.

TABLE 3

SPECIES COMPOSITION BEFORE AND AFTER SALVAGE IN SECOND-GROWTH STANDS, AT 1,900-2,100 FEET ELEVATION, ON THE KANE EXPERIMENTAL FOREST, ELK COUNTY, PA.

Species	Stand composition[1]	
	Be ore	After
	Per cent	*Per cent*
Sugar maple	19.8	26.5
Yellow birch	8.1	9.8
Sweet birch	7.9	8.8
Red maple	6.9	7.3
Beech	14.6	14.9
Black cherry	34.2	20.2
Eastern hemlock	6.7	10.1
Miscellaneous	1.8	2.4
Total	100.0	100.0

[1]Based on percentage of total volume in cubic feet.

ELEVATION, LATITUDE, ASPECT, AND LOCAL CLIMATIC CONDITIONS

Both elevation and aspect were controlling factors in the amount of glaze damage on any particular tract. Second-growth well-stocked stands on the Kane Experimental Forest occur at elevations ranging from 1,700 feet to 2,100 feet above sea level. Division of the elevations into four 100-foot classes reveals (Table 4) that damage increases very distinctly with increase in elevation. Serious damage began at about 1,900 feet in northwestern Pennsylvania, while in New York damage was general above 1,000 feet with some in places reported even below 600 feet. Increasing latitude enhanced the effect of elevation, while sizeable bodies of water such as Lake Ontario and the Finger Lakes in New York decreased glaze damage in their vicinity.

Because the Kane Experimental Forest lies upon a plateau, dissected by several small streams, marked differences in aspect were not available for study. Tallies made on the Armstrong Forest Company holdings and ocular inspection of other areas have shown unmistakably that north and east slopes suffered heavier damage than did the south and west slopes. This is verified by the light damage found on the one south-facing slope of the experimental tract. Possibly snow on the north and east slopes and bare ground on the south and west aspects created the local climatic conditions favoring greater deposition of ice and consequently greater damage on the former. The amount of ice accumulated and thus the severity of damage depends on the amount of precipitation falling while conditions favorable to freezing prevail.[7] Exposure to wind is another external factor contributing to the extent and degree of glaze damage.

[7]Downs, A. A. Weather conditions during the glaze storm of March 17-19, 1936, in Pennsylvania and New York. Mo. Weath. Rev., Vol. 65, No. 3, March, 1937.

Salvage and Stand Improvement Cuttings

The present condition of damaged ands calls for immediate salvage to inimize present losses and sanitation ork to minimize future losses. In se-erely damaged stands salvage should roceed as rapidly as markets will per-it, because after two or three years the own material will be badly decayed. adly broken, split, bent and uprooted ees should be cut and utilized in such perations. Stand improvement work ich as stand sanitation cuttings should e conducted in connection with the sal-age operation. With so many oppor-inities for infection present,[8] diseased ees which may act as sources of infec-on should be removed. Nor should the anger of insect epidemics be overlooked; eakened and insect-infested trees should so be cut. Considering the future stand, rest sanitation is fully as important as e salvage operation. For the next few ars constant vigilance must be main-ined to suppress any insect or fungous itbreaks.

Long-Range Prevention of Glaze Damage

Although of unprecedented severity so r as present records are concerned, the saster of 1936 is not to be regarded as unlikely to occur again. William Ander-son of the Soil Conservation Service re-calls a severe glaze storm in 1900 in New York state, and a slighter one since then. Other individuals describe glaze storms in the past which damaged timber. Abell[9] says that glaze storms in the Southern Ap-palachians are not infrequent: residents of western North Carolina recall four in the last 75 years. These observations in-dicate that glaze storms are not of infre-quent occurrence and because of their catastrophic nature should be considered in forest management plans.

In both damaged and undamaged stands measures which tend to minimize future glaze damage are synonymous with good silviculture. The following are suggested:

1. Remove holdovers. Not only are such wolf trees undesirable but their large spreading crowns make them prize victims of glaze damage; and when they come down, they do much damage to the smaller trees around them.

2. Reduce the proportion of suscepti-ble species. In general a larger percent-age of conifers should be encouraged on sites subject to glaze damage.

3. Preserve an even canopy. Weedings and thinnings should tend to release a slow-growing species like sugar maple much more than a fast-growing species like black cherry which in youth tends

Table 4

AZE DAMAGE BY ELEVATION IN SECOND-GROWTH STANDS ON THE KANE EXPERIMENTAL FOREST, ELK COUNTY, PA.

evation	Basis: number of trees	Trees damaged	Trees severely damaged	Volume per acre: Total	Volume per acre: Severely damaged	
		Per cent	Per cent	Cords	Cords	Per cent
00-1800	1,916	2.3	1.3	22.70	1.10	4.8
00-1900	3,128	12.1	7.8	25.56	3.63	14.2
00-2000	10,885	22.1	17.3	26.39	8.60	32.6
00-2100	6,606	30.4	25.2	23.67	9.57	40.4

[8]The size of wounds, especially those exposing heartwood, is of utmost importance in decid-g which trees should be left and which should be removed in stand sanitation cuttings. See ticle by W. A. Campbell entitled "Decay hazard resulting from ice damage to northern hard-ods."

[9]Abell, C. A. Influence of glaze storms upon hardwood forests in the Southern Appalachians. ur. For. 32:35-37. 1934.

to project above the general canopy and develop a large crown very susceptible to glaze damage. For the same reason discourage sprout growth.

4. Use group silviculture for species of widely different growth habits. Large spreading crowns are prevented when species of similar growth rate are reproduced in groups.

5. Modify local silviculture with elevation and aspect. For example, at higher elevations and on northerly aspects sugar maple and hemlock should be encouraged at the expense of black cherry.

Summary

The glaze storm of March 17-19, 1936, damaged the forest on six million acres in Pennsylvania and New York. Immediate losses of forest products will be considerable due to the inability of the market to absorb all salvageable material before it decays. Future losses will take the form of decreased volume growth, resulting from destruction of crowns and opening the stand to soil desiccation; and decreased quality growth, resulting from deformity, ravages of rot and insects, and entrance of weed trees into the stands.

Tables and graphs show that damage increases with increase in size of tree; in age of the stand; and in elevation of the site. Southerly aspects suffered less than northerly ones. Because of their greater flexibility and manner of growth conifers as a whole were more resistant to glaze injury than hardwoods.

The existing situation should be met by immediate salvage of damaged trees, and stand sanitation to minimize future losses. Measures to lessen damage from future glaze storms are synonymous with good silviculture, and the maintenance of a larger proportion of conifers where practicable.

A Service for Members

DURING the present session of Congress, several members have written to the Society's office in Washington requesting copies of bills affecting forestry and conservation and reports on pending legislation. This is a service which the secretary's office is glad to render, and members of the Society desiring such information are urged not to hesitate to use the facilities available.

Likewise, members who expect to visit Washington, whether for business or pleasure, are invited to make the Society's office their headquarters. Hotel reservations and business appointments will gladly be made upon request, and any other similar services performed that may be of convenience to visiting members.—Henry E. Clepper, *Executive Secretary*.

BRIEFER ARTICLES AND NOTES

PROGRAM OF FORESTRY SECTION
ASSOCIATION OF SOUTHERN AGRICULTURAL WORKERS

Atlanta, Georgia

February 2, 3, 4, 1938

Chairman..................R. W. Graeber, Raleigh, N. C.
Vice-Chairman.......... J. S. Holmes, Raleigh, N. C.
Secretary..........................G. H. Lentz, Atlanta, Ga.

February 2—2:00 P. M.

SYMPOSIUM: RECENT FORESTRY LEGISLATION AS IT AFFECTS THE SOUTH

1. The Agricultural Conservation Program in Relation to the Forest Crop on the Farm—T. L. Ayers, Principal Agricultural Economist, Southern Division, A.A.A., Washington, D. C.

   Discussion—Extension Foresters.
2. The Norris-Doxey Cooperative Farm Forestry Act—E. W. Tinker, Assistant Chief, U. S. Forest Service, Washington, D. C.
3. Recent Trends in Forest Legislation in the States—Chas. W. Gillett, State Forester, Little Rock, Ark.
4. The Lumberman's Viewpoint on the Forestry Porgram for the South—Julian F. McGowin, Chapman, Ala.

   General Discussion.

February 2—7:00 P. M.

BANQUET AND SOCIAL ACTVITIES FOR FORESTERS AND GUESTS

Joint meeting of Appalachian, Central States, Gulf States, Ozark, Southeastern, and Washington Sections of the Society of American Foresters.

February 3—9:00 A. M.

SYMPOSIUM: THE PULP AND PAPER INDUSTRY IN THE SOUTH

1. Timber Farming—A New Agriculture -Hon. Harry L. Brown, Assistant Secretary of Agriculture, Washington, D. C.
2. The Pulp and Paper Industry in Relation to Forest Farming in the South—Matt Rue, Brunswick Peninsula Company, Brunswick, Ga.
3. Fitting Timber Farming Into the Farm Management Program—Oscar Steanson, Bureau of Agricultural Economics, Division of Farm Management, Washington, D. C.
4. Should Publicly Employed Foresters Discuss Timber Values and Prices in Meetings and With Timber Owners—W. W. Henderson, N. C. Pulp and Paper Company, Plymouth, N. C.

General Discussion: How Can Pulp Mills Be Guaranteed a Permanent Supply of Timber?—Directed by Gus H. Lentz, U. S. Forest Service, Atlanta, Ga.

February 3—2:00 P. M.

SPECIAL GROUP CONFERENCES

Meeting of southern group of Extension Foresters
Meeting of southern group of State Foresters
Meeting of southern group of American Pulpwood Association
Meeting of lumbermen sponsored by Southern Pine Association

A Suggested Method of Converting Some Heavily Nectria-Cankered Hardwood Stands of Northern New England to Softwoods

There are in northern New England numerous and extensive areas of hardwood pole forest heavily cankered by Nectria, of poor composition and density, and with little or no softwood reproduction. The original forest certainly had a considerable percentage of softwoods intermixed with hardwoods. Lumbering and fire have greatly reduced the proportion of softwoods, in some localities almost to extermination. The duff and humus also have been burned off, resulting in poor site conditions. Some of these areas are at such elevations, or are so exposed, that hardwoods can produce only short, or poorly formed, stems at best. The native softwoods (chiefly red spruce) make satisfactory growth at such elevations and seem to be better adapted to the poorer site conditions.

Nectria canker is so destructive in many such areas that usual improvement operations will leave a stand so sparse as to be almost useless. Conditions seem to indicate clearly that ultimate conversion to softwoods, or to a heavy admixture of softwoods, is the only method of improving such stands for timber production. Clear-cutting of the heavily cankered stand is liable to result in a new stand just as heavily cankered as the present one, because the natural conditions are unfavorable for the best growth of hardwoods and decidedly favor the disease.

Since natural softwood reproduction is scanty and poorly distributed and complete planting is considered impossible at present, natural seeding by suitably spaced seed trees would be a welcome solution of the problem. The beginning of such seeding can be brought about within the next 20 to 30 years: (1), by releasing properly spaced trees in the natural softwood reproduction already on the ground; and (2), by planting groups of 50 or more 4-year red, white, or Norway spruce transplants at intervals where no natural reproduction is present. The intervals between groups should be at least twice the diameter of the groups. The released trees already on the ground should be seeding in a reasonably short time if they are kept free to grow rapidly. The planted groups would need to be given a chance to grow at maximum rate also. But the expense for cleaning and weeding would be held at a minimum because of the wide intervals between the groups. Thus, about 25 years after starting, natural seeding should be going on over the entire area, and portions should have already seeded from the natural reproduction which was already present.

The cost of such treatment will be held at a minimum and yet speed up the desired result as compared with the time required for the natural seeding of the area by the poorly distributed natural reproduction now present. Moreover, this does not interfere with whatever improvement work may be undertaken with the hardwoods, nor does it prevent complete planting of the area if that becomes possible any time in the future. In the meantime the hardwoods remaining on the ground will protect the site and build up the deficient duff and humus layer, thus making possible the reestablishment of the microflora and fauna destroyed by fire.

The writer is not advocating indiscriminate conversion to softwoods because of Nectria, but there are areas where this seems to be the only method of improvement likely to yield good quality timber.

Perley Spaulding,
Division of Forest Pathology.[1]

[1]In cooperation with the Northeastern Forest Experiment Station and Yale University.

Plant Palatability Varies With Year, Research Reveals

A wide variation exists from year to year in the palatability and utilization of desert range forage, according to a report from the Intermountain Forest and Range Experiment Station, following research studies conducted on the winter range from 1932 to 1935 inclusive.

These observations clearly indicate some of the difficulties involved in compiling a standardized index of palatability for desert range plants and emphasize the need for continued observation of plant growth as a basis for developing sound management practices.

Such factors as climatic conditions, composition of vegetation, growth, seasonal use, and differences in herds are the causes of palatability variations, the report states. Variations were found to be especially noticeable between wet and dry years. For example, white sage was 85 per cent palatable in 1933, 65 per cent palatable in 1934, both dry years, and dropped down to 30 per cent palatable in 1935, a relatively wet year. This species was particularly low in palatability on areas supporting an abundance of other kinds of forage, but when more or less alone, it was utilized from 60 to 80 per cent. The woody stems of the 1935 growth appear to have influenced its palatability.

Shadscale also grew luxuriantly in 1935 and for the first time in many years the growth extended about 2½ inches beyond the heavy armor of spines, thus making forage readily accessible to sheep. Similarly, the palatability of curlygrass increased approximately 100 per cent in 1935 over the previous three-year period, presumably because of the increased growth it made during the season.

Following is a table showing the relative palatability of principal forage species based on detailed observations of utilization on the winter range during the period 1932-35:

	1932	1933	1934	1935
Ricegrass	95	95	85	90
Curlygrass	35	35	40	70
Dropseed	10	10	15	15
Blue grama	5	5	10	10
Blue grama (spring use)	45	35	45	55
Black sage	95	90	85	90
White sage	80	85	65	30
Budsage	5	0	5	5
Budsage (spring use)	90	80	85	90
Shadscale	30	25	25	55
Mormon tea	65	50	70	----
Globemallow	60	80	50	90

A White Spruce Plantation in New Hampshire

The accompanying photograph (Fig. 1) of a plantation of white spruce in northern New Hampshire shows the excellent development attained by this species on old abandoned pasture land. The plantation was established in the spring of 1930 with stock obtained from the Laurentide Nursery at Proulx, Quebec. The trees were two-year transplants, that is 2-2 stock. The spacing was 6 x 6. The planting was carefully done by a naturalized Russian, who used what he called "old country method," meaning the careful type of planting which he had learned in Russia.

When measured in July of this year the plantation illustrated herewith showed a survival of 98.8 per cent of thrifty and vigorous trees without sign of disease or other injury. The average height of the trees was 4.88 feet.

This plantation is on land belonging to the St. Regis Paper Company in the town of Pittsburg, Coos County, N. H., and is located along the main road from Pittsburg to First Connecticut Lake and

approximately one-half mile west of the lake.

It is planned to remeasure the plantation at frequent intervals and reports on its development will no doubt be of interest to readers of the JOURNAL OF FORESTRY.

A. B. RECKNAGEL,
Cornell University.

A SIMPLE FORMULA FOR MAKING DIAMETER PREDICTIONS

The forester has need for time-saving devices and short-cut methods, at least for those which do not detract from accuracy. In making short-term diameter predictions, accuracy is frequently sacrificed for speed of calculation. Not infrequently foresters assume that future diameter growth will be identical with past growth, for lack of a simple and accurate means of predicting the future growth. A formula is herewith presented which will give fairly reliable, short-term predictions of future diameters.

To predict the future diameter of a tree it is first necessary to determine its present diameter and its diameter at a definite time past. The interval between the past and present diameters must be equal to the period over which the prediction is to be made. The method may be stated as follows: the future diameter is found by extracting the square root of the difference between twice the square of the present diameter and the square of the past diameter. Or, stated as a formula:

$$F = \sqrt{2D^2 - P^2}$$

in which F equals the future diameter, D equals the present diameter and P equals the past diameter, (as many years past as "F" is in the future).

Assume that it is desired to predict the future diameter (10 years hence) of a tree 12.3 inches in diameter which shows a periodic growth in radius of 0.9 inches in the last 10 years. The diameter 10 years ago was 10.5 inches. Doubling the

Fig. 1.—A seven-year-old white spruce plantation in northern New Hampshire.

square of the present diameter (12.3 inches) gives 302.58 and the square of the past diameter equals 110.25. The difference between these values is 192.33. The square root of the difference gives a future diameter of 13.87 inches or 13.9 inches.

This method of making diameter predictions is based upon the assumption that periodic growth in basal area tends to remain fairly constant, regardless of tree size or condition. The formula is an obvious derivative of the basal area method of forecasting the growth of single trees, aptly described and illustrated by Baker.[1]

When used for predicting future diameters (or growth) of single trees this formula method is as easy of manipulation as any growth per cent formula, and is generally more reliable. The formula can likewise be used as a substitute for the rather awkward curvilinear process which is the conventional solution of a short-term (yield) prediction problem. Tests showed a slightly higher correlation between diameters predicted by the formula method and the true future[2] diameters, than between those predicted by the curvilinear method and the corresponding true future diameters. Additional tests indicated that the formula tends to give more conservative and more accurate results than does the conventional method.

When past growth is determined by increment borings, the neglect of bark growth does not materially influence the result for single tree predictions. The growth of bark may be taken into account in precise studies, however, in the manner described by Chapman and Demeritt.[3]

The formula is not suggested for the purpose of supplanting any existing methods of making growth predictions. It is a fairly accurate, easily remembered and easily applied method of predicting future diameters over short periods. As such it may be of value to foresters in the calculation of future diameters with a minimum of computation, while in the field.

Allyn M. Herrick,
Purdue University.

The Effect of Origin of Stand on the Site Index of Longleaf Pine

About 70 per cent of the 214 plots from which the second-growth longleaf pine yield tables were constructed were taken in natural stands; the other 30 per cent were taken in old-field stands that came in on abandoned agricultural lands. When the longleaf yield tables were constructed, these two types of stands were not considered separately, but were merged into a single set of tables.

In an endeavor to find out whether natural and old-field stands have the same site index (average height of dominant trees at 50 years of age), the basic plot data were separated into the two groups, the resulting curves for which are shown as solid lines in Figure 1. Since these are free-hand curves, it is possible that the differences indicated are not significant. To decide this point, the two sets of original data were grouped according to 10-year age classes. The statistics for each group, as given in Table 1, indicate that the two curves are significantly different, but this lack of agreement cannot be ascribed to differences in age within the group because the average ages for each group show close agreement.

The average site indexes of natural and

[1]Baker, F. S., The theory and practice of silviculture, McGraw-Hill, New York. Page 398. 1934.

[2]Tests were made using growth figures from 1917 to 1927 as past periodic growth, and 1937 diameters as true "future" values.

[3]Chapman, H. H. and D. B. Demeritt. Elements of forest mensuration, 2nd Ed. J. B. Lyon, Albany, N. Y., 1936. Paragraph 201.

old field stands, as read from these curves, are 68 and 76 feet, respectively. Using the site-index figures in table 65 of the yield tables[1] as a basis, the curves for site indexes 68 and 76 have been constructed, as shown by the broken lines in Figure 1. The curve for natural stands is above that of the corresponding yield-table curve for both the young and old age classes, the maximum difference being 4 feet at 100 years. The curve for old-field stands is below the corresponding yield-table curve for ages under 50 years, and above that of the corresponding curve for ages over 50 years. This discrepancy indicates that an old-field stand of 50 years would, according to the yield table, give average dominant trees 83.5 feet high at 60 years of age, whereas the actual height would probably be 81.6 feet. A 15-year-old stand on an old field with dominant trees averaging 34 feet high would indicate a site index of $\frac{34}{28} \times 76 = 92$ feet, whereas the curve based on old-field stands alone would in-

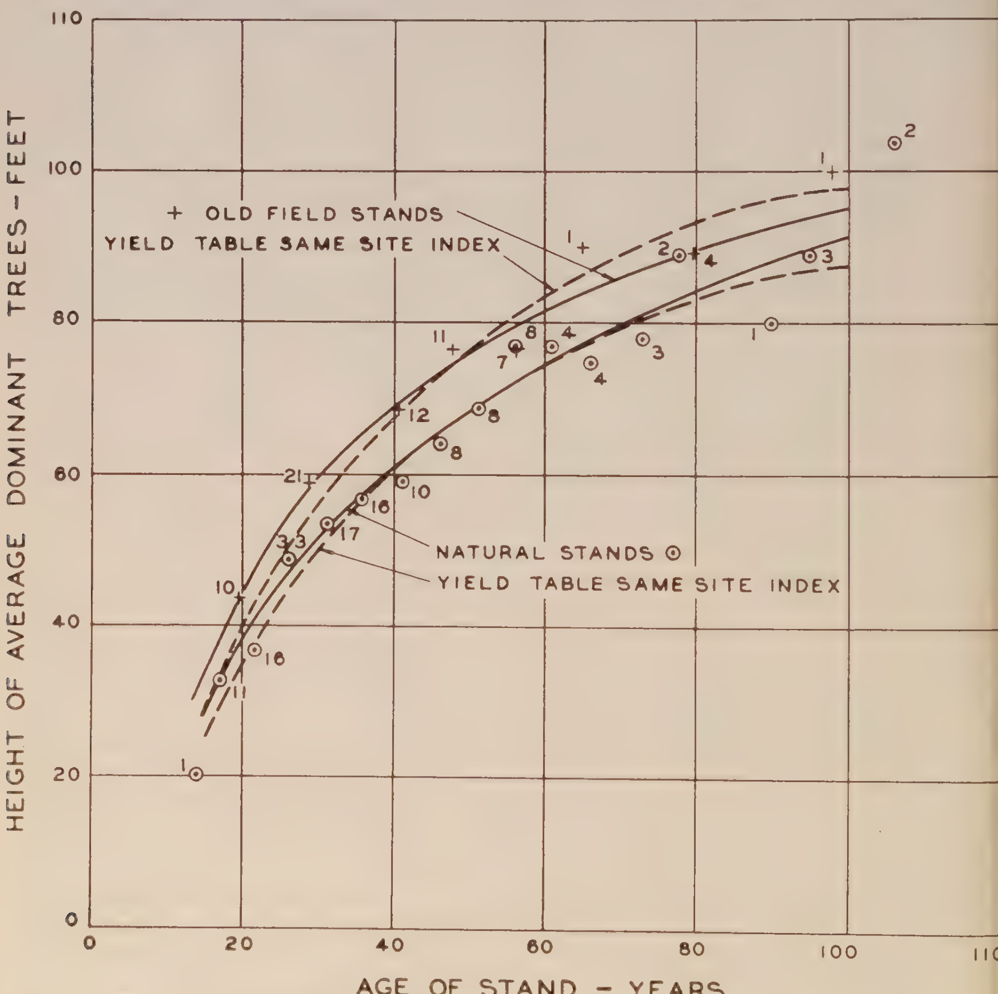


Fig. 1.—The relation between age and height of average dominant longleaf pine in natural and old-field stands.

[1]Volume, yield, and stand tables for second-growth southern pine. U. S. Dept. Agr. Misc. Pub. No. 50. September, 1929.

dicate a site index of 76 feet. For natural stands a somewhat similar situation arises except for ages 40 to 60, where the two curves are almost coincident. A natural stand 20 years old with dominant trees averaging 38 feet high would have a site index of $\frac{38}{35} \times 68 = 74$ feet, whereas the curve based on natural stands alone gives a site index of 68 feet.

This brief analysis indicates, therefore, some of the inaccuracies in yield tables constructed by combining data from natural and old-field longleaf stands.

R. A. Chapman,
Southern Forest Experiment Station.

Shaker Pines Forest

Many members of the Society of American Foresters, especially graduates of the Yale and Harvard Forest Schools, are already familiar with the famous Shaker Pines Plantation at Enfield, Conn., located about three miles east of the Connecticut River and adjoining the Massachusetts boundary ten miles south of Springfield. Eastern foresters will be interested to know that it recently was purchased and reserved as a "model forest enterprise" by the Shaker Pines Forestry Corporation. The price paid for the area was $14,000 or $48 per acre. The corporation is incorporated for $14,500 and was organized by leading members of the Connecticut Forest and Park Association.

The corporation was formed and the property acquired for the following objectives:

(1) To save from destructive lumbering the remaining part of perhaps the earliest and largest pine plantation in America.

(2) To establish a practical demonstration of good corporate forestry.

(3) To prove, if possible, that a well-located forest of superior quality, containing several age classes and a reasonable amount of semi-mature timber can be managed on a sustained yield basis.

The Shakers, or so-called followers of Mother Anna Lee, were an old time religious sect. One of their earliest settlements was established at Enfield, Conn., in 1787. According to local tradition that part of the land acquired by the sect just east of an attractive lake, now known as Shaker Pines Lake, was allotted for permanent timber production. The open field portion of this area was sown to pine in about 1871—nearly a century after the settlement was established—by Elder Omar Pease, who was especially interested in forestry and horticulture. Red and white pine, mixed with buckwheat, was sown broadcast and a thick stand of pines, now 66 years old, resulted. Due to the excellent soil quality and the high water table, this area appears to be especially well adapted to pine. On at

Table 1

Significance of the difference between the height of average dominant trees on old-field and natural stands (second-growth longleaf pine)

Age class	Old field: Number of plots	Old field: Average age	Old field: Average height	Natural stand: Number of plots	Natural stand: Average age	Natural stand: Average height	Difference in height	t[1]
Years		*Years*	*Feet*		*Years*	*Feet*	*Feet*	
10-19	6	18.0	41.8±3.30	12	17.2	31.8±2.96	10.0±4.43	2.26
20-29	16	25.9	55.3±2.00	49	24.8	44.8±1.19	10.5±2.33	4.51
30-39	12	33.3	62.0±2.35	33	33.6	55.0±1.40	7.0±2.74	2.55
40-49	15	43.4	71.7±1.58	18	43.6	61.4±1.93	10.3±2.49	4.14
50-59	12	54.3	77.1±2.13	16	53.8	72.9±2.49	4.2±3.28	1.28
60+	6	80.3	91.2±3.69	19	77.5	82.9±1.89	8.3±4.15	2.00

[1]A t value (t is the difference between the two means divided by the standard error of the difference) of 2 or more is considered statistically significant.

least a portion of the area the forest is now growing at the high rate of 1,568 ft. b.m. per acre annually.

The Shaker Pines Forest, 291 acres in area, is easily reached by several nearby main highways. Because of the level terrain and many woods roads all parts of the area are readily accessible for logging and silvicultural operations at all times of the year. A cruise of the area made recently by the Connecticut State Forest Service showed a merchantable timber volume of 1,308,400 ft. b.m., chiefly pine, and 721 cords of wood. Both sawtimber and cordwood can be disposed of locally on the stump at good prices. The last sale of timber was made at the rate of $8.00 per M. The Shaker Pines forest includes 60 acres of the original pine planting. This now has a fully stocked understory of semi-suppressed pine and hardwood seedlings. Large groups of pine also occur in the mixed hardwood stands. In both these types heavy thinnings of merchantable timber should now be made. Seventy-five acres of mixed hardwoods of cordwood size, now 40-60 years old, also require rather heavy improvement cuttings. Excellent reproduction, especially of young pines and also of the better hardwoods, occur on all parts of the tract. The property includes a stretch of about one quarter mile of lakeshore on beautiful Shaker Pines Lake which will be make available to stockholders and interested visitors for picnicking and camping.

The active management of the property has been undertaken by James L. Goodwir (Yale Forest School 1910), aided by the State Forester, members of staff of the Yale Forest School, and local foresters. The actual operations will be carried on by selling marked stumpage on an acreage or contract basis. At the present time taxes on the area amount to about $110 but as soon as the land is classified under a recent special Connecticut forest law they can be reduced to about $75 annually.

Although the purpose of the enterprise is not primarily for investment purposes competent foresters feel that it affords a unique opportunity for a combination of good corporate forestry, security of principal, and the possibility of a moderate income.

George A. Cromie,
New Haven, Conn.

Forest Cover Keeps Frost Line at Shallow Depth[1]

Recent observations carried on by H. F. Scholz at the LaCrosse Soil Erosion Station show that in the forest, frost penetrates the soil to a much less depth than in open fields and pastures.

During the winter of 1936-37, measurements of the depth of frost were taken at each of ten stations in an ungrazed woodlot and also in an open pasture consisting of closely cropped bluegrass sod. The measurements which were obtained by means of a standard soil sampling tube first were taken fortnightly, and later at more frequent intervals.

The average depth of frost as well as the average depth of the snow mantle for both cover conditions is illustrated in the charts below.

The frost in the open pasture was found to penetrate to an average depth of 10 inches, that in the woodlot to a depth of only 4 inches. Although the snow was somewhat deeper in the woods than in the pasture, this difference was not enough to account for the great difference in frost depth.

The manner in which the frost left the ground is also of interest. In the open pasture, the direct rays of the sun and the above-freezing air temperatures pro-

[1]Technical Note 130. Lake States Forest Experiment Station. Maintained by the U. S. Department of Agriculture in cooperation with the University of Minnesota.

gressively thawed out the soil, beginning at the surface and working down into the subsoil until the frost had completely disappeared. In the woodlot, however, at those points where frost still occurred,[2] thawing evidently took place from the subsoil up, for in no case did the ic*e* crystals disappear in the surface soil prior to the thawing of the lower layers. Yet all frost had disappeared in the woods two days before the pasture soil was completely thawed.

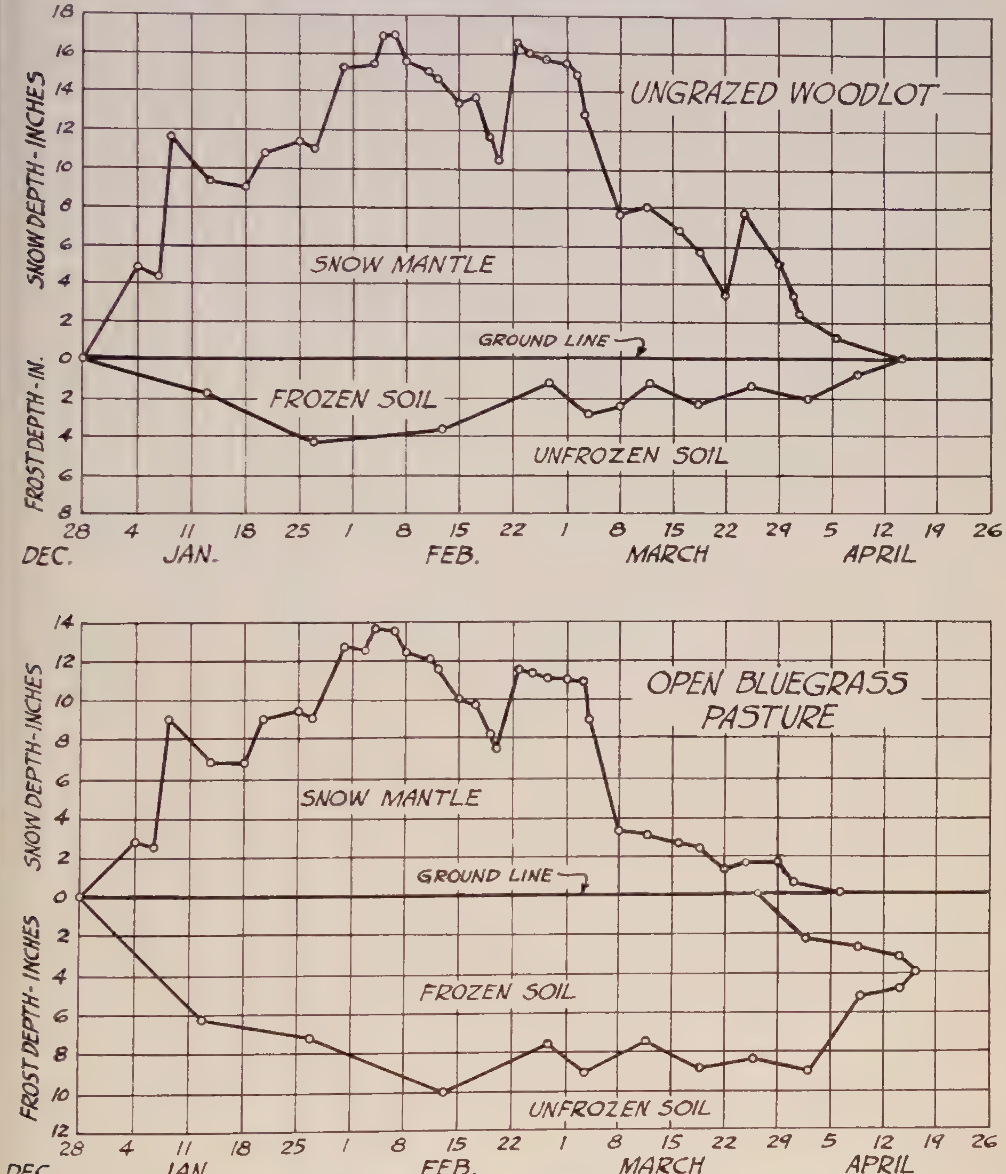


Fig. 1.—Average snow and frost depth measurements, December 28, 1936-April 26, 1937, La Crosse, Wis.

[2]Only for about a four-week period during January was the soil frozen at all ten stations in the woodlot.

REVIEWS

Principles and Methods of Tree-ring Analysis. By Waldo S. Glock, with a foreword by A. E. Douglas, and a contribution by G. A. Pearson. *Carnegie Institution of Washington Pub. 486. viii + 100 pp. 14 pl., 44 fig. 1937.*

Probably no recent study involving the principles of mensuration as applied to vegetation has had as wide appeal to scientists and the laity alike as that of attempting to determine the occurrence of past, and to predict future precipitation cycles through variations found in tree-ring widths. Parenthetically, it may be added that no greater disappointments, perhaps, have been encountered by sincere and patient workers than in this type of study, because of failure to find correlation between tree growth and precipitation. Possibly too much has been expected; nevertheless, the offering of a technique, such as contained in the present work, should be well received.

As pointed out in the foreword of the bulletin, the work in tree-rings has had several phases of development, notably: cross-dating to establish identical dates in different trees; cycle analysis; and the establishment of chronologies and the study of ancient trees in attempts to interpret prehistoric bioclimatic relationships. The climatic history of an area is not easily interpreted, for, as Douglas points out, the physical relationships work in many directions, involving study of climatology, plant physiology, and that phase of ecology which is concerned with the reaction in the tree to climatic changes.

The technique offered is presented in three parts. Part I, "Tree-Ring Analysis," is devoted to a lucid description of procedure, accompanied by many illuminating diagrams. The inexperienced worker should find this section of value.

In Part II, "Ring Uniformity in a Ponderosa Pine," the results of a detailed study of a single ponderosa pine are reported. The purpose is to test the uniformity of growth in transverse sections at various points along the bole. The consistency of the tree within itself was thought to be important as an indication of whether the ring widths of a single specimen would show consistency with those of other trees. The principal purpose of the study, however, appears to have been to test the validity of cross-dating of different trees according to especially wide or peculiar rings when the numbers of rings do not exactly correspond in the trees that are being cross-dated.

It is well known that a growth ring might be missing at one radius and present in another. A discrepancy in the number of rings between two cross-dating points in different trees, however, need not lessen the reliability of the especially wide or the peculiar rings as a chronological record. It is important to realize that the average of four radii from a transverse section of a tree would provide a true record of tree-ring growth. The averaging of the different radii, however, is for the purpose of avoiding errors due to missing rings in one or more radii, for such "misses" constitute a problem in very dry climates where the study probably is of greatest interest.

The author concludes that if there is uniformity in the rings of a given tree there is corresponding uniformity among groups of trees. This conclusion requires further proof before it can be generally accepted.

In carefully selected ponderosa pine samples collected in California, where precipitation is limited, uniformity in the rings among groups and of especially selected individual trees is clearly lacking. The author recognizes the importance of uniformity in ring sequence among trees in samples of a universe, and realizes the value of further research along this line. Accordingly, conclusions in the form of a law challenge special scrutiny. Glock evidently bases his proposed law upon two sets of observations: (1) The width of the tree-rings reflects the amount of rainfall when the latter is below the minimum, for the "reliability of ring sequences" increases as rainfall decreases; (2) as mean rainfall decreases, the percentage fluctuations increase proportionally (*p. 91*). It is not clear whether the author's conclusion is based upon the belief that the tree-rings vary more widely because a given amount of "rainfall increment" is utilized more efficiently in laying down cellulose in the stem, or because the percentage fluctuations in the mean rainfall are greater as the mean rainfall decreases. Incidentally, it seems remotely probable that the similar law proposed by Braun-Blanquet for light could lend support to that of rainfall increment. Obviously, the newly proposed law must stand on its own merits. Probably the chief objection to the proposal of the law is the implication of finality, which certainly has not been attained in tree-ring study.

Part III embraces a discussion of tree-rings as climatic indicators. The earlier sections on factors influencing the growth of trees, prepared in his characteristically thorough way by G. A. Pearson, summarize well the effect of various habitat factors on growth. The various important factors influencing growth of ponderosa pine, however, except for precipitation, are not given consideration by Glock.

Data are presented to show that tree-rings may be a reliable indicator of climate. Most of the attempts at correlations are done with precipitation, which is obviously the limiting factor in many parts of Arizona. The author considers that local factors other than climate affecting tree-rings are eliminated by the selection of only so-called "normal" trees, and especially by the combining of many trees and many groups well distributed over a region.

Three methods of ring climate study have been employed. In analyzing ring type it is necessary to determine whether the dominant characteristic of a ring sequence is complacent (uniform) or sensitive. Uniform growth is an indication of ample moisture, whereas relatively wide fluctuations in ring widths are generally an indication of deficient or variable moisture.

In the analysis of sensitive individual rings, thick rings are indicative of unusually favorable climatic conditions. Thin rings indicate less favorable conditions, especially inadequate water supply, whereas double rings are indicative of two rather distinct rainy seasons within a single growing season.

In the analysis by cycles the purpose is to show that groups of tree rings are indicators of climatic cycles. It is held that in dry climates the maxima and minima of the cycles are larger and the double-crested 11-year cycle is more pronounced.

The importance of the average annual rainfall is discussed. Optimum rainfall is associated with maximum ring thickness and slight variations in annual growth. Excessive rainfall restricts growth as does deficient rainfall.

The summary of the work leaves the reader somewhat confused as to the highlights of the problem, probably because of the attempt to combine opinions of other workers with the more basic points presented in the paper. Accordingly, the fundamentals upon which the conclusions are based are rather seriously masked.

The theory of climatic cycles seems to be omnipresent. However, unless cycles are shown to be reasonably dependable for periods for which climatic records are available, they can have little other than

speculative value as past and future climatic indicators.

Arthur W. Sampson,
University of California.

Perpetuation of Spruce on Cut-over and Burned Lands in the Higher Southern Appalachian Mountains. By Clarence F. Korstian. *Ecological Monographs 7:125-167. 20 fig. 1937.*

In a well written paper, illustrated by excellent photographs, Korstian presents a discouraging but not hopeless picture of the mishandled spruce forests of the Southern Appalachians. Like the salient of a battle front reaching deep into enemy territory, the spruce forests of the north send a long tongue far into the southland, but only along the high ridges and lofty summits of the Appalachian ranges. There, for countless centuries, the spruce forests have successfully withstood the onslaughts of nature, only to be decimated in a short span of years by the destructive actions of man.

An extensive study of cut-over and burned spruce land throughout the Appalachian region convinced the author that depletion of the spruce forests is due chiefly to fire following destructive logging. Repeated fires destroy the organic material in the upper soil layers, inducing serious erosion, and thus leave the forest floor unsuited to natural reproduction of spruce. Dense thickets of raspberry and blackberry take possession of much of this burned land and these are promptly followed by an abundance of hardwoods, principally pin cherry and yellow birch. Nevertheless, some spruce reproduction eventually succeeds in establishing itself, though generally in inadequate amounts. Unburned cutover areas normally show a greater number of spruce seedlings than the burned cutover lands. The rapidly growing hardwoods, however, soon over-top the slower-growing spruce and seriously hamper its establishment and normal development.

Korstian points out that a system of prompt detection and suppression of forest fires is absolutely essential to the restoration of spruce forests on cut-over and burned-over lands. Much planting, too, must be undertaken if the original conifer cover is to be restored within a reasonable time. As a further means of perpetuating spruce forests he advocates selective or partial cutting, if any cutting at all is to be done on these areas of high watershed value.

Korstian's findings and recommendations in this study of spruce in the Southern Appalachians are strikingly similar to those obtained by investigators in the spruce forests of northeastern United States and Canada.

M. Westveld,
Northeastern Forest Experiment Station.

Man in a Chemical World. The Service of Chemical Industry. By A. Cressy Morrison. *xi+292 pp. Illus. Charles Scribner's Sons, New York and London. 1937. Price $3.*

John Winthrop, Governor of Connecticut, is credited with having established the first chemical industry in America in 1635, although the glass furnace set up by Captain John Smith soon after his settlement in Virginia should perhaps have the credit. At any event, the American Chemical Society celebrated the three hundredth anniversary of the industry in 1935. In connection with this occasion, the Tercentenary Committee of the Society sponsored the preparation and publication of a book which should explain to the general public the contribution of the chemical industries to the everyday life and well-being of Americans. The author has produced a book that is exceedingly readable and at the same time accurate. "Keeping Well,"

"Feeding Millions," "From Papyrus to Television," "All the Comforts of Home," "The More Abundant Life," are only a few of the intriguing chapter headings. The book can be commended to those who desire to obtain a broad view of the scope of the chemical industry and its indispensable service to modern existence and comfort.

W. N. SPARHAWK.

Farm Timber Crop in Arkansas. By Richard D. Stevens. *Univ. Ark. Coll. Agric. Ext. Circ. 396. 30 pp., 7 fig. 1937.*

Farm woodlands in the South make up 30 per cent of the forest area. In Arkansas alone, 6.5 million acres are classed as such. This land has a dominant economic bearing upon the rural population, which depends upon it for products for farm and home needs, and for cash income.

Stevens emphasizes methods of integrating the farm forest more fully with a well-balanced program of agriculture. He touches on practical phases of silviculture, selective logging, timber cruising, use of volume tables, home use of forest products, marketing farm forest products, and growth and yield in farm woodlands. The circular is an example of the valuable contribution that practical foresters can make in developing farm forest programs through presenting forestry knowledge to farmers in complete, yet simple, understandable language.

M. H. BRUNER,
Extension Forester, Arkansas.

Das Aufaesten der Waldbaeume (Pruning of Forest Trees). By Hans Mayer-Wegelin. *58 pp. Illus. M. & H. Schaper, Hanover. 1937.*

This pamphlet is a condensation of the author's previous work, "Aestung," published in 1935. It deals with the principles of, and the rules for, pruning forest trees in planted and natural stands. Chapter headings include: "Purpose of Pruning," "Stem Form and Pruning," "Green vs. Dry Pruning," "Applicability of Pruning," "Selection of Stands to be Pruned," "Choice of Stems to be Pruned," "Time and Costs of Pruning," and "Records of Pruning." All this is set forth in great detail and is followed by specific rules for pruning the principal German forest trees (including Douglas fir) and by illustrations of the right and wrong way to prune.

Such intensive practice is rarely commensurate with American forest conditions, but wherever pruning is practiced the principles Mayer-Wegelin sets forth should be carefully followed. Thus he favors early and frequent pruning; the designation of crop trees, and "dry" rather than "green" pruning. The study of this work is commended to all silviculturists.

A. B. RECKNAGEL,
Cornell University.

The Practice of Silviculture. By Ralph C. Hawley. *Fourth Ed. xiv+252 pp. Illus. John Wiley & Sons, Inc., New York. 1937. Price $3.*

As stated in the author's preface to this edition, the principal change in this standard work on American silviculture has been to remove from it the chapters devoted to forest protection with a view to publication in a separate book (which has already appeared). This, according to the author, was done because the material covering silvicultural methods and protection has become so voluminous as to make an unwieldy text book, and for the further reason that protection is now generally taught in separate courses at most forest schools. It might be added that protection from fire, insects, or disease, while still a responsibility of the general forest admin-

istrator, has become from many aspects the work of specialists. Thus this separation of the subject matter meets general professional needs as well as those of instruction in these subjects. Future development of these texts will also be facilitated.

It should be noted that the scope of the book is further limited by omitting material dealing with "silvics" or the foundations of silviculture. Also, as pointed out by the author, it is impossible in a country with so large a number of commercial tree species to include any adequate discussion of the silviculture of all important native species in a book dealing with silvicultural practices. The author states that he now has in preparation a book dealing with silvicultural handling of individual tree species. Our profession may therefore look forward to the completion of a well-rounded presentation of the entire field of silviculture, including forest protection.

As noted in reviews of the former combined text published in the February, 1929, (p. 190) and April, 1934, (p. 442) issues of the JOURNAL, the separate subject matter of the present book is handled in a systematic manner to fit the requirements of a text book. From the standpoint of the practicing forester it might be desirable to place less emphasis on methods which are much less used than in the past and lay more emphasis on methods now in growing repute. It is, for example, probably fair to observe that a general movement is on foot to get away from clear-cutting practices except as small groups or strips are involved. On the other hand, it seems true everywhere that a major movement is under way drastically to shorten the periods of time and the percentage of time during which the soil is occupied exclusively by seedlings or other premerchantable stands and to increase the percentage of time that the soil is producing growth on merchantable stems, with special emphasis on quality stems. The means used include methods of overlapping the period of growth on merchantable stems with the regeneration and pole stages as in the *Dauerwald* system; the similar modernized application of the selection system by the "*méthode du contrôle*" school of foresters; cultivation to speed development of young stands where clear cutting has still to be used; and under all systems deferring the felling age on selected stands and stems. It appears that in further development of this text the author could not do better than to investigate and expand his treatment of such measures as are winning broad professional support in various countries.

The last five chapters of the book are devoted to intermediate cuttings, control of cuttings, and various cultural operations.

Finally, comment is pertinent on the need of the practicing forester for a matured literature (over 30 years have gone into its development) of this type. In sharp contrast to its western European counterpart, it is characteristic of the American profession that its administrative burdens, whether thrust upon it or self-imposed, its absorption with forest policy, and with the "social aspects" of forestry have effected an almost complete divorce from interest in or practice of a refined silvicultural technic. Too many foresters take the view that these problems are of very minor importance, ignoring the fact that effective silvicultural practices constitute an indispensable foundation for high levels of forest productivity in quantity and quality. For these reasons foresters, whether in administrative positions or in positions directly concerned with technical problems, should freely take advantage of the easy accessibility of the descriptions of modern silvicultural practice offered by this and its companion volumes, to renew their knowledge of these technics. This is the more readily done because of the easily understood style and the language free from hyper-technical terminology.

BURT P. KIRKLAND,
U. S. Forest Service.

Accounting in the Lumber Industry. By H. W. Eckardt. *291 pp. Illus. Harper & Bros., New York and London. 1929.*

Foresters employed in the lumber industry, and some engaged in government service, come in frequent contact with cost figures, valuations, and other financial information obtained primarily from the accounting records of lumber companies. The interpretation and use that foresters may make of such information will be determined to a large extent by their own particular knowledge of how the data were obtained.

Mr. Eckardt's text is not recent but it should be reviewed by foresters who wish to reinforce their knowledge of accounting in the lumber industry. The only other textbook that deals entirely with this particular subject seems to be "Lumber Accounts" by Walter Mucklow, which was published in 1936 by the American Institute Publishing Company of New York. It is believed that Eckardt's work, which is less detailed, will be of greater value to foresters.

This book attempts to show the solution to the ordinary accounting problems, and to set up standard accounting procedures for the lumber industry. The author seems to have an excellent background of experience in lumber accounting. He has presented his material in an orderly manner, and has reinforced the more difficult portions with adequate illustrated forms and examples.

It is obvious that not all details of a technical book on a specialized field of accounting will interest most foresters. It is believed, however, that of the nineteen chapters in the book, the following would be of definite interest to those engaged in forestry work involving financial or economic problems:

I. Introduction
II. The Balance Sheet
III. The Profit and Loss Account
IV. The Lumber Accounts
V. The Log Accounts
XIV. Supplementary Manufacturing Costs
XVI. Burden Cost Controls
XVII. Depreciation.

Mr. Eckardt emphasizes the lack of uniformity and the need for standardization of accounting procedure in the lumber industry. Throughout the book he covers the various methods used in dealing with particular problems, but is careful to emphasize the recommended practice. This approach is particularly effective in the chapter on depreciation, where several different methods of computing it are described. Of these the "Straight Line" and "Relation of Timber to Investment" methods are recommended for general use.

It is unfortunate that the relationship of one record to another is not made more concrete by using charts or outlines. This may not be required by accountants, but it would have made the work more complete for the foresters and lumbermen who may refer to it. The book will, however, be particularly valuable to foresters for reference or for intensive study of specific accounting problems.

W. S. Bromley,
U. S. Forest Service.

CORRESPONDENCE

October 26, 1937.

Hon. Henry Wallace,
Secretary of Agriculture,
Washington, D. C.

DEAR MR. WALLACE:

Senate Bill 2970 for Reorganizing the Agencies of the Government permits the transfer of the national forests back into the Department of the Interior, a jurisdiction from which Theodore Roosevelt rescued them in 1905.

The popular support for this transfer comes from the urban centers, whose citizens, for the most part, have but one conception of conservation and that is to preserve the wilderness, stop lumbering and grazing, prevent water power and irrigation development, and give absolute protection to wildlife regardless of consequences to the balance of natural forces. With the organization of the National Park Service in 1915 the Department of the Interior quickly sensed the enormous potential value of this support and directed it with increasing virulence against the Forest Service in the Department of Agriculture which administers the national forests.

Mr. Ickes personally is a typical exponent of these sentiments. In addition, he is inspired by the powerful urge to restore the prestige of his Department which has suffered through the stubborn persistence, in the U. S. Land Office, of the policy of lavish disposal of the public domain, until with nothing left to give away this office is a mere skeleton of its former strength.

Conservationists who have sought for 40 years to establish sound economic policies of land use on public land are appalled at the effrontery of a department which in the light of the achievements of the Department of Agriculture and its own sorry record, persists not only in utterly ignoring this historical development, but in accusing those who defend it of anti-conservation activities and lobbying.

This body of informed conservationists includes the Society of American Foresters, the American Forestry Association, the National Grange, the American Farm Bureau Federation, the Izaak Walton League, the National Association of Audubon Societies and others, who on sound historical, scientific, and public grounds are opposed to the proposed segregation, in the Department of the Interior, of jurisdiction over all public lands.

There is widespread dissatisfaction with the official efforts of the Secretary of Agriculture during the present drive against the Forest Service. The members of the Forest Service and other agencies in the Department of Agriculture have been muzzled by official orders and not even permitted to testify before Congress on such proposed legislation.

Public statements, by radio and press, emanate from the head of the Department of the Interior and members of his organization, with no effective official rejoinders or defense whatever from Agriculture. In previous crises the will for defense was not found lacking from Secretary James Wilson down. With the entrance of the Forest Service into the Department of Agriculture in 1905, that Department ceased to be a mere educational and advisory agency dealing solely with one group of citizens, the farmers.

It then became, whether it was recognized or not, the outstanding public agency for the direct administration of public land for the specific purpose of conserving by wise use the organic resources of the soil, namely, forests, forage, and wildlife. It became in effect the Department of Conservation of Organic Resources through multiple use. The Department of the Interior handled mineral resources, Indians and their lands and education, national parks by default, and other miscellaneous tasks, and continued to permit excessive misuse of the open range.

While supporting the national forest administration, the Department of Agriculture has signally failed to put up effective resistance or aggressive assertion in order to effect the logical integration of land use policies demanded by the correlation of public land management with education and regulation of private owners. As the direct result of this lack of aggressiveness it now faces the prospect of being relegated to the narrow concept of an agency exclusively concerned with the interests of the farming population. This will not meet the present needs of conservation.

The Department of Interior and its partisans in a series of bitter attacks on the Forest Service intended, and with considerable popular success, to create the opinion that the Forest Service in defending the public interests and policies for which it is responsible was resisting the public good solely for reasons of bureaucratic jealousy.

Instead of openly and publicly standing up for these policies, the Secretary of Agriculture has refrained from doing so and by rigid orders has prohibited any such expressions by any members of the Department on pain of dismissal. Thus the responsibility for officially informing the public must rest squarely on the shoulders of the Secretary himself, and so far there has been no satisfactory evidence that he intends to redeem this responsibility.

It would appear, in the absence of other evidence, that the Department of Agriculture is complacent and willing to be shorn of this large and indispensable element in its program, and content to permit its future activities to be confined to the farmer alone. The responsibility for such an outcome will again rest solely on the shoulders of its Secretary. Conservation of organic resources is no longer confined, if it ever was, to the farm, nor are farmers alone by any means a majority of those interested in conservation of these resources.

The Secretary of Agriculture by his own orders is the only official mouthpiece for the broad program in agriculture which includes all organic resources. Either he must defend this historic and efficient policy or the Department of Agriculture must take the consequences of a disruption of this program as sought by the Department of the Interior. In the latter case, conservationists will have to begin anew, and endeavor to rebuild the shattered structure on an entirely new and less effective basis.

Respectfully,

H. H. CHAPMAN,

President, The Society of American Foresters.

November 20, 1937.

MY DEAR PROFESSOR CHAPMAN:

I have read with interest your letter of October 26. I appreciate the frankness with which you, as President of the Society of American Foresters, have stated the position of that body.

I have, of course, been aware of the concern many sincere individuals and groups have expressed over the proposal to change the name of the Department of the Interior to Department of Conservation, as included in Senate Bill 2970 for

reorganization of agencies of the government. I am necessarily familiar with the various interpretations which have been made of the possible effect of this proposed bill on the Department of Agriculture in carrying out its many times expressed policy of coordinated land use. As the son of a former Secretary of Agriculture, I have learned something of the historical development of the Department of Agriculture and its many bureaus. I know the fine ideals which have inspired the men and women who have created its traditions of unselfish public service.

Since March 1933, as Secretary of Agriculture in both terms of President Roosevelt, I have known intimately his tremendous efforts to promote a sound land use policy in this country. I shall not take occasion here to go into details because I am sure you are quite familiar not only with the efforts which have been made in this direction but also with the many tangible results already evident. Much remains to be done, but I believe it is fair to say that the people of the United States have through these efforts been made increasingly aware of the imperative necessity of conserving through wise use both their reproductive and nonreproductive natural resources.

Conservation—spread over as broad a field as it is—is not the function of one agency but a fundamental underlying social principle of governmental action. The real difficulty arises when the means are considered for accomplishing what we all want done. This gives rise to honest differences of opinion as to methods, and opportunity for discussion. Free expression of differences of opinion is a right which we all possess within a democracy. There is certainly no intention on my part, and there has been none, I can assure you, on the part of the President, to abridge, curtail or infringe in any way on that right. I have sincerely felt, however, that it is not only wise but sound policy for all Departments of the government to work out differences of opinion through the regularly established channels of the executive and legislative branches of the government. This has been, and still is, the established policy of the Department of Agriculture.

I fully realize that in certain circumstances such a policy, unless observed by all in a spirit of good will, might give rise to impressions such as those you state have occurred in this situation. Notwithstanding this, I am ready personally to assume the responsibility for working out through the duly constituted agencies of government an organization of the Department of Agriculture which can redeem its responsibilities for the management of crops, both long and short time, and for those functions which are vital to a unified agriculture and coordinated land use program. This I am hopeful can be done without recourse to open conflicts over jurisdiction between the various departments.

I sincerely want to see the President's main objectives in reorganization achieved. Everyone interested in improving the public service realizes that some reorganization of the government service is necessary. Here again arise differences of opinion. I believe that during the present session of Congress, when this whole matter will be given consideration, full opportunity will be afforded to bring out what defects there may be in the proposed plan and what changes seem wise to secure the most effective governmental organization, including specifically those for conserving our natural and human resources.

The President is, I am sure, so vitally interested in this whole subject of conservation in its broad national aspects that he will give most careful consideration to all points of view brought out in discussions of his proposals for reorganization.

H. A. Wallace,
Secretary of Agriculture.

November 27, 1937.

DEAR MR. WALLACE:

Allow me to express the appreciation of the Society for your courteous letter of November 20th.

In view of the continued campaign of propaganda issuing from the office of the Secretary of the Interior, may I renew my suggestion that the general public is entitled to a frank and informing statement from your office as to the real issues involved in this campaign to shift the administration of publicly owned lands, including the National Forests, to that Department.

In addition to the radio address of recent date, one-half of which was devoted to personal abuse of a former Chief Forester, Gifford Pinchot, and a press release of November 18 attacking and denouncing the officers of the Izaak Walton League, and charging that their opposition to his proposed Department of Conservation was unauthorized by the League members and brought about by influences whose source has not yet been revealed, Mr. Ickes in his annual report has reiterated his claim to a monopoly of conservation projects, including soil, as reported in the press, as follows: "In accounting for the stewardship of the Department in administering a vast national estate, water protection, and prudent use of land, our greatest national resource, Mr. Ickes recalled to the President the admonition of Theodore Roosevelt nearly thirty years ago that 'when the topsoil is gone, men must go, and the process does not take long.' For the first time since 1908 we have in the seat of government an administration that is giving actual heed to that warning! The Commissioner of the General Land Office points out that the work of the General Land Office has undergone a decided change in recent years. Conservation rather than disposal, is now the dominant note in the administration of the public lands under existing laws."

The report, as have its predecessors, utterly ignores the established and successful program of soil, forest, and grazing conservation, free from political influences, as administered by the Department of Agriculture.

As it stands, the public battle for true conservation by wise use and renewal of organic resources is being waged without help or encouragement from the Department charged with this responsibility, whose employees, having borne the brunt of a thirty-year struggle against political opposition and public indifference are now prevented by your orders from giving the facts to the public which the public is entitled to know as citizens on whom the consequences of maladministration will fall.

The Society therefore urges you in the interests of the Nation and its future welfare to extend to your own administrative force the same freedom of expression now enjoyed by the agents of the Department of the Interior and its Secretary, in order that our citizens and their representatives in Congress may not have to depend for their information solely on the voluntary efforts of informed individuals and associations having no official connection with the Department.

While speaking for the Society of American Foresters in this matter it is well to emphasize the fact that the following national associations have openly declared their position as opposing the proposed legislative provisions in S 2970 which would make possible the disruption of the entire program of soil and forest conservation. These are:

American Association for the Advancement of Science.

American Farm Bureau Federation.

American Paper and Pulp Association.

American Forestry Association.

Farmers Union.

General Federation of Women's Clubs.
Izaak Walton League of America, Inc.
National Cooperative Council.
National Grange.
National Lumber Manufacturers Association.
National Retail Lumber Dealers Association.
Union of American Biological Societies.

H. H. CHAPMAN,
President.

November 18, 1937.

DEAR MR. CHAPMAN:

I have read with much pleasure and approval your item in the November JOURNAL OF FORESTRY, "Norway Versus Red Pine". There is no question about the facts being as you state them.

A parallel case—which I hope the Forest Service has not recently reversed—is the ancient one of Douglas spruce vs. Douglas fir. As I recollect it I was the chap who in 1905 persuaded the Forest Service officially to change over to Douglas fir in accordance with the prevailing commercial practice in the northwest.

R. S. KELLOGG.

DEAR DOCTOR SCHMITZ:

Your editorial, "The Mirror of the Profession," and correspondence in the July and September issues of the JOURNAL raise questions which I hope will be debated to a constructive conclusion.

The main criticism of the JOURNAL seems to be that it is loaded with technical articles of little interest to the profession as a whole. Right here one might ask if foresters should not be interested in technical questions but I am not going to assume the role of preacher. Your editorial and Mr. Clepper's letter point out that the JOURNAL can publish only the material which members submit. Those who want a different type of article should write more of the kind they like. The common alibi of a lack of time is not very convincing. Preparing manuscripts for publication, regardless of the subject, usually consumes a lot of midnight oil. It is surprising how many, even in the research group, have no time to write.

After all, the purpose in publishing a journal is not only to furnish reading matter of current interest but also to record professional thought and achievement. An important function is to provide an outlet for individual expression. No doubt these ideas were uppermost in the minds of the founders of the Society when they named the original publication "Proceedings of the Society of American Foresters."

If the general run of foresters do not read technical articles, it probably is less because they are not interested than because technical stuff often makes difficult reading. This might be said of articles on administration, policy and legislation, as well as those dealing with scientific problems. Serious subjects can seldom be adequately treated in popular language. But there is no reason why a "heavy" paper, after it has been published in the JOURNAL and thus placed on the official record, cannot be rewritten for the benefit of the layman and the professional man in allied fields.

President Chapman's proposal to publish two separate journals, one technical and the other popular, seems to offer a possible solution. In my opinion the difference between the two should be more in form than in subject matter. The popular magazine ought not to sidestep technical subjects but should aim to make all its articles readable, though necessarily at some sacrifice of detail. The official organ of the Swedish popular forestry society, *Skogsvardsföreningens Tidskrift*, goes deeply into all phases of timber man-

agement as well as administration, policy and legislation. It reprints many articles from the reports of the Swedish forest experiment station in practically their original form. There is a wide gap in American forest literature between the "heavy" type of technical articles or bulletins and the ultra-popular type. Both have their place but they should be supplemeted by a third type of literature which presents in simple, direct language the important developments in research and practice for the benefit of individuals who already accept the principles of forestry. A considerable portion of the thinking public is fed up on propaganda and would like to see more evidence of substantial accomplishment.

To finance this additional publication would require the support of the entire profession and additional subscriptions from nonmembers. Many foresters who balk at paying $8 per year for membership in the Society might be willing to pay $4 a year for a readable magazine. Also, the general public should not be overlooked. Such periodicals as *The Scientific American*, *Popular Science* and the numerous airplane magazines must derive a considerable part of their financial support from popular subscription. Why should not forestry, in all its varied aspects, attract a comparable number of readers?

G. A. Pearson,
Southwestern Forest and Range Experiment Station.

Dear Dr. Schmitz:

The current discussion in the Journal concerning the types of papers appearing in it brings up a question that can never be satisfactorily settled as long as many of the members of the Society expect to find every article or at least almost every article of interest to them like, say *Colliers*. The profession of forestry covers such a wide field that it is unreasonable to expect the official organ completely to satisfy each month all its members. Much of the value of the Journal lies in the fact that it does contain many technical papers in fields outside of one's particular interest. There should be more of them. They keep one informed of the latest advances that are being made in the profession and of the trend of thought of the profession as a whole.

Among several other scientific journals; I subscribe to the *Annals of the Entomological Society of America* and to *Science*. Although the former is a quarterly the subscription rate is about the same as for the Journal, and although probably more than half the articles are entirely out of my field I do not feel that I am not getting my "money's worth". *Science*, a weekly, likewise costs about the same as the Journal and likewise contains many articles that do not interest me but it keeps me informed on what is going on in the general field of science as a whole and because it does is of considerable interest.

One of the functions of the Journal should be to keep the members of the Society mentally alert, and just because we have closed the class-room doors behind us forever is no reason for closing our minds to class-room knowledge. I have heard several foresters remark that but few articles in the Journal were of interest to them. Such a remark is more of a criticism of the attitude of the speaker than of the contents of the Journal.

One possible way of making more appeal with the Journal to all its readers would be to add a page similar to "Scientific Notes and News" that appears each week in *Science*. Such a page of items would do much to make the Journal seemingly more interesting to the average reader.

Donald DeLeon,
Bryce Canyon National Park.

Dear Dr. Schmitz:

To my way of thinking, it is all wrong to set up an arbitrary requirement of a fixed number of university credits for admission into the Society beyond the very definite requirements that are already in existence. After all, the Society is not an honorary school fraternity. It is a professional society which, to my mind, should interest all men connected with forestry whether they are "swivel chair" or "dirt" foresters, government foresters, or logging foremen.

The field of forestry is too broad to say that to be a member of the Society you must have so many university credits of silviculture, so many credits of economics, etc. I believe that the best way to coordinate the several land use divisions is to get the men interested into one society where they can meet on a common ground and thrash out their problems of infringement and overlapping. What organization can better furnish this common ground than the Society of American Foresters?

Gregory Baker,
University of Maine.

Dear Dr. Schmitz:

I was deeply interested in the article that appeared in the October issue of the Journal by R. H. Westveld, entitled "Farm Forestry Education in the Agricultural Curriculum."

We, here at the University of Tennessee, realize that a new forestry must be offered, especially to agricultural graduates, and that they need some training in forestry. I am whole heartedly in accord with Mr. Westveld's article and would like to see more agricultural colleges offer such a course. It is by no means an easy task to include a course in farm forestry in the agricultural curricula, as Mr. Westveld mentions, due to a greater flexibility in the college curricula. We who are teaching forestry in agricultural colleges, and our forest extension workers, have a great responsibility in the field of farm forestry education. The need for the inclusion of a required course in forestry for agricultural students comes to my attention constantly and such a course should be a requirement in the agricultural curricula. Even more is it necessary with the addition of extension workers under the Norris-Doxey Farm Forestry Act, who will be selected from men trained in agricultural colleges, and should have a conception of what it is all about.

Within another year I believe we, here at the University of Tennessee, will have included in our agricultural curriculum farm forestry education, perhaps consisting of several entirely new courses.

I would personally like to see a further discussion in the Journal regarding farm forestry education in the agricultural curriculum.

Henry Dorr, Jr.,
University of Tennessee.

November 10, 1937.

The Honorable,
The Secretary of the Interior,
Washington, D. C.

Subject: Colorado Big-Thompson Reclamation Project (S. 2681).

Sir:

The Camp Fire Club of America, through its Conservation Committee, has consistently opposed any attempt to inject commercial projects within the confines of a National Park.

In 1923 or '24, this Club formulated certain standards relating to the formation and administration of National Parks. These standards have very generally been accepted by organizations throughout the country. Even the National Park Service has given its approval to these standards.

When this reclamation project was first contemplated, the original plans involved entry upon and defacement of the surface of the Rocky Mountain National Park and in other ways violated the standards above referred to, as well as

those of the Service itself, which to a certain extent have been adopted by Congress.

The objection to the instant project, in which The Camp Fire Club of America joined, has justified itself, as the original plans have been so amended that the eastern exit of the tunnel will be outside of the eastern boundary of the Park, and nowhere will the surface of the Park be touched or marred.

In the October 1937 issue of the JOURNAL OF FORESTRY, there is an article by Prof. H. H. Chapman, President of the Society of American Foresters, written only after "an investigation covering 15 months and including two trips in Colorado". Certainly after such a thorough investigation by a man of sufficient standing to be honored with the presidency of this noted Society and to hold, as he has for so many years, a professorship in the Yale School of Forestry, credence must be given to his statements and his conclusions should be carefully considered. Professor Chapman's article clearly demonstrates that this reclamation project will not involve the surface of the Park, and will not constitute an invasion into the natural conditions for the preservation of which the Rocky Mountain National Park was created.

This is the sole interest of The Camp Fire Club of America involved in this subject.

Furthermore, if that provision of the act of 1915 creating the Park which authorizes the Reclamation Service to "enter upon and utilize for flowage or other purposes any area within said Park which may be necessary for the development and maintenance of a government reclamation project," was inserted in the act as a promise to the citizens of Colorado, in return for their acquiescence in the creation of this Park, that the Park would not become a barrier to such project, then to fail now to abide by such promise would seem to be a breach of faith.

The Camp Fire Club of America would be unwilling to become a party to such a breach of faith.

Therefore, the amended plans having removed the causes for the objections recorded, The Camp Fire Club Conservation Committee and the Board of Governors of The Club have approved this letter and authorize the statement that they have no objection to the amended plans for the instant reclamation project provided the amended plans are adhered to in so far as that all surface work shall be excluded from within the boundaries of the Rocky Mountain National Park.

Respectfully,

WILLIAM B. GREELEY, *Chairman,*
Committee on Conservation of Forests and Wildlife of The Camp Fire Club of America.

DEAR PROFESSOR HAYES:

Your question regarding a 5th year is one of absorbing interest at present, and bids fair to attract more attention as time goes on.

The question is, whether forestry, as a profession, can continue to get by with a 4-year course. Engineering is quoted as a precedent, but in this far narrower field, specialization is practiced, as you know, in these curricula, and there is much complaint as to the inadequate basis of engineering education. Perhaps it is unfair, as yet, to compare forestry with such professions as medicine or law which are moving towards additional undergraduate preliminary education.

It has been my feeling right along that forestry educators *can* map out the fundamental professional requirements of a trained forester, and that, as yet, these *basic* subjects can be acquired in 2 years of a 4-year course.

The difficulty comes from two directions. First, in the demand for more cultural subjects, which would reduce the

time in the 4-year course to less than 2 years. One institution is trying the experiment of crowding courses into about half the usual number of credit hours, and thus providing for this expansion. I don't yet know how this is working but believe there is a limit and serious drawbacks. The other difficulty is obviously that of attempting specialization too soon and thus reducing the hours for basic forestry, or in some cases almost completely eliminating them. Special courses in wood utilization, etc., are the worst examples.

A third difficulty is involved in the attempt to give even *basic* training in too many branches allied to forestry, such as game management. A further aspect of this problem is that of specialization in such subjects versus equipping the forester with enough knowledge to permit him to administer the game resource with the aid of consulting specialists.

Two choices seem open to institutions grappling with this problem. First, is to postpone the degree in forestry to the end of a 5th year, introducing more culture and not completing the basic subjects, such for instance as forest management, until this time, while at the same time giving opportunity for limited specialization in game, wood utilization, etc., *and* giving a degree of Bachelor of Forestry, in the 5th year, with a B.S. degree at the end of the 4th year.

The other plan is to arrange the course so as to meet reasonable requirements for basic training in *forestry* at the end of the 4th year—if the schools and profession can ever agree in what this consists of. This plan would give B.F. or B.S.F. at the end of the fourth year and devote the 5th year to specialization in one or more lines, as post-graduate work, with perhaps an M.F. degree in the line of the specialization.

I hope the Educational Conference will have something to say on these subjects.

H. H. Chapman, *President.*